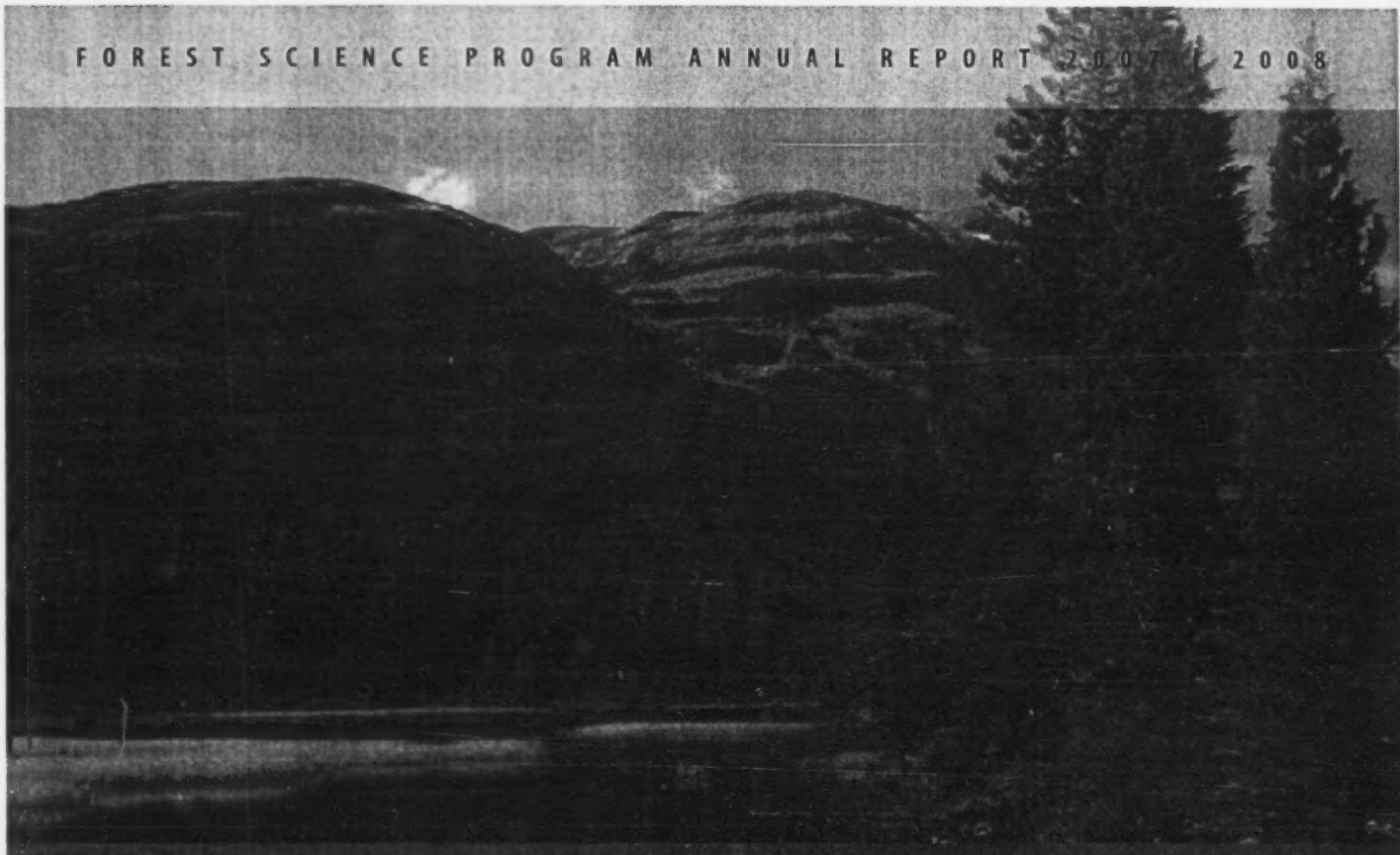
FOREST SCIENCE PROGRAM ANNUAL REPORT 2007 | 2008



science to support sustainability

07 | 08

Ministry of Forests and Range

Forest Science Program Mission Statement

Helping to provide innovative solutions to high-priority forest resource management issues in British Columbia and seeking opportunities to advance resource stewardship based on sound scientific principles.

Abbreviations:

BCTS—BC Timber Sales

BEC—Biogeoclimatic Ecosystem Classification

CCLUP—Cariboo-Chilcotin Land Use Plan

EBM—Ecosystem-based Management

FEEI—Future Forest Ecosystems Initiative

FFT—Forests for Tomorrow

FGC—Forest Genetics Council of British Columbia

FIA—FSP—Forest Investment Account—Forest Science Program

FORREX—Forest Research Extension Partnership

FREP—Forest and Range Evaluation Program

FRPA—Forest and Range Practices Act

FSP—Forest Science Program

GIS—Geographic Information System

IUFRO—International Union of Forest Research Organizations

MFR—Ministry of Forests and Range

MFR/FSP—Ministry of Forests and Range Forest Science Program

MPB—Mountain Pine Beetle

TASS—Tree and Stand Simulator

TIPSY—Table Interpolation Program for Stand Yield Information

TSR—Timber Supply Review

UBC—University of British Columbia

Forest Science Program Mission Statement

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Executive Summary

During the 2007/08 fiscal year, the scientific work undertaken by researchers in the Ministry of Forests and Range Forest Science Program (MFR-FSP) continued to improve forest management policies and practices. Researchers addressed a diversity of forestry-related needs, and extended research findings to a wide range of clients. This report focusses on those achievements, especially as they relate to improving operational management practices, responding to the effects of the mountain pine beetle (MPB) epidemic, and addressing concerns about climate change through the Future Forest Ecosystems Initiative (FFEI).

Recent improvements in the Biogeoclimatic Ecosystem Classification (BEC) system and the Tree and Stand Simulator (TASS) model are two examples of Forest Science Program accomplishments that directly assisted operational management practices and decision-making. This past fiscal year, large-scale BEC mapping was completed for much of the Province; district-level BEC maps and tools were revised; new field guides were developed for areas currently under-represented by the BEC system, such as alpine and subalpine zones, northern boreal forests, Queen Charlotte Islands ecosystems, and Garry oak plant communities; scientific information on disturbance history was summarized for each BEC zone; and training courses were provided to several interagency groups, including the Haida Guardians. The Beta version of TASS III was also released this year, featuring improved projections of forest growth under complex silvicultural treatments and harvesting patterns. This latest version incorporates a windthrow model, and growth and yield data for hardwood species, such as red alder and trembling aspen. Including coastal hardwood species in the model supports the Coastal Forest Action Plan goal of encouraging hardwood harvesting and planting.

One of the most critical challenges for forest managers this past year was in developing effective and appropriate responses to the MPB epidemic and its impacts on the environment, the economy, and society. The FSP directed considerable attention towards several issues, with particular focus on the need to maintain watershed stability and normal hydrological function in areas affected by large-scale salvage logging of beetle-killed trees. This involved FSP researchers designing risk assessment procedures for wet, inoperable sites resulting from accelerated salvage harvesting; developing solutions to minimize flooding in logged areas; identifying watershed, forest cover, and site indicators for assessing watersheds at risk; and creating operational salvage strategies for mitigating MPB-related impacts on watersheds. Through various extension activities and products, FSP researchers also presented information on the effects of the MPB infestation on watershed hydrology to clients as diverse as the Northern and Southern Regional Management Teams, BC Cattlemen's Association, district Timber Supply Analysis steering committees, First Nations Band Councils, and public groups.

The ongoing and potential effects of climate change on British Columbia's natural systems continue to concern the Ministry of Forests and Range. In response, the Forest Science Program participated in creating the Future Forest Ecosystems Initiative (FFEI), which is tasked with assessing the vulnerability of the Province's forest and range resources to climate change, and determining requirements for adapting current policy and management practices to ensure that forest and range productivity remains sustainable. One of the most important achievements made in this area involved refining the seedlot selection guidelines based upon FSP modelling of the relationships between adaptive genetic and ecological variation. Additionally, FSP researchers identified seed selection schemes that maximize forest productivity under changing climatic regimes.

Also in response to climate change and the FFEI, improving the understanding of carbon cycles was yet another field of concentration for the FSP in 2007/08. Carbon budgets were examined through research on the effects of grazing on soil carbon sequestration and storage in rough fescue grasslands, and also on the extent and abundance of secondary structure in MPB-affected forest stands. Researchers as well participated in two carbon-flux studies assessing how MPB disturbance changes the forest carbon balance and how fertilizing Douglas-fir forests influences carbon uptake.

With worldwide concern growing over the need to conserve biodiversity, the FSP also focussed on maintaining British Columbia's natural biodiversity. The Program's emphasis was largely on providing information to help adjust standard operational management policies and practices. FSP researchers also examined ways to address the effects on biodiversity of projected climate changes and the impacts from salvage harvesting in MPB-affected forests. Accomplishments in this discipline included producing guidelines for alternative harvesting systems and silvicultural treatments to develop and enhance Spotted Owl habitat, designing timber harvesting strategies to maintain mule deer winter range in various snowpack zones, incorporating Marbled Murrelet habitat quality classification into species-at-risk recovery planning, and developing site-level retention strategies for salvage harvesting in mountain caribou habitat. Looking ahead, researchers assessed possible indicators for monitoring changes in biodiversity. They examined using forest-floor arthropods as indicators of forest management impacts on biodiversity, and identified species particularly sensitive to environmental conditions (such as tailed frog) to potentially serve as indicators of future habitat changes.

These and other achievements made by the Forest Science Program during the 2007/08 fiscal year addressed both current information needs and emerging issues related to British Columbia's forest and range sectors.

Letter of Transmittal

Jim Snetsinger, Chief Forester
Assistant Deputy Minister, Forest Stewardship Division

Phil Zacharatos
Acting/Assistant Deputy Minister, Operations Division

Re: Report on Forest Science Program Activities, 2007/08

On behalf of the Forest Science Program (FSP), I am pleased to present this report on our activities for the 2007/08 fiscal year. The report describes the forest science initiatives of all four organizational units within the program: the Research Branch, and the Forest Science Sections in the Northern Interior, Southern Interior, and Coast Forest Regions.

The FSP builds scientific knowledge and expertise necessary for improving science-based forest resource management. In part, the work focusses on generating new knowledge from a complement of short- and long-term research projects pertaining to priority topics in forest policies and management practices. An equally important part of the Program is to maintain a well-informed cross-section of scientific expertise ready to address urgent management issues.

This year's report includes a section on the efforts of FSP researchers to facilitate the translation of science to management in response to challenges faced by the Ministry of Forests and Range (MFR). Featured in the report are the FSP's contributions to resolving operational management concerns, including participating in the development of a credible and effective Forest and Range Evaluation Program to evaluate whether practices under the Forest and Range Practices Act *are meeting government's legislative objectives and the broader goal of sustainable resource use. Other highlighted initiatives involve responding to the unprecedented devastation of interior forests by the mountain pine beetle, and providing science to support the MFR's response to climate change through the Future Forest Ecosystems Initiative.*

Active involvement in applied field research enables FSP researchers to stay current, credible, and capable of responding to emerging policy and operational issues. During 2007/08, the FSP continued to strive for a balance between short-term research initiatives that respond to current information demands and long-term research that can be used to predict trends and impacts over time.

This past year, the FSP focussed on improving its organizational effectiveness by identifying client needs and issues, and pursuing new opportunities for improving communication and client relationships to strengthen its client-service orientation. In November 2007, for the first time in 10 years, a multidisciplinary gathering of FSP employees from across the Province focussed on how to best support new MFR initiatives. The meeting provided a unique opportunity to identify new approaches of responding to emerging issues, and a forum for sharing ideas and innovations amongst researchers throughout the provincial FSP. An internal working group was also formed to develop a process for evaluating and protecting the MFR's research installations to ensure their optimal future utility.

Researchers in the FSP made significant progress during 2007/08 in many areas, and supported the development of improved policy and best management practices. I am confident that the Forest Science Program will continue to have significant positive impacts on the business of the Ministry of Forests and Range, thereby contributing to the recognition of British Columbia as a world leader in forest stewardship.

Gerry Still, Director
Research Branch

Forest Science Program Overview

The Forest Science Program (FSP) provided, during the 2007/08 fiscal year, research expertise within the Research Branch and all three forest regions in the core disciplines of ecology, geomorphology, hydrology, silviculture systems, soils, and wildlife habitat. Also available at the Branch was specialized expertise in fields such as range ecology and climatology. The Research Branch also housed provincial-level programs in the areas of forest genetics and stand development modelling. Additionally, the Branch co-ordinated multi-faceted and multidisciplinary research around specific provincial issues such as the mountain pine beetle (MPB) epidemic.

The Ministry of Forests and Range has a legislated mandate to manage, protect, and conserve British Columbia's forest and range resources. As part of both the Forest Stewardship and Operations Divisions, the Forest Science Program's mission is to provide innovative solutions for high-priority forest resource management issues in British Columbia and to seek opportunities for advancing resource stewardship based on sound scientific principles. The FSP directly supported the Ministry's mandate and its Divisions' priorities by:

- undertaking a portfolio of long-term, short-term, and retrospective research projects selected to meet the Ministry's 2007/08–2009/10 Service Plan goal of sustainable forest and range resources, providing the scientific foundation for many top-priority Ministry initiatives such as the *Forest and Range Practices Act* (FRPA), Forest and Range Evaluation Program (FREP), Future Forest Ecosystems Initiative (FFEI), Mountain Pine Beetle (MPB) Action Plan, and Forests for Tomorrow (FFT),
- refining models and analytical procedures to improve growth and yield projections for Timber Supply Reviews (TSRs) and second-growth management,
- developing decision-support tools that incorporate socio-economic analyses into land use and higher-level planning, and
- providing scientific leadership on emerging issues such as managing genetic resources, non-timber forest resources, and forest carbon.

Forest Science Program Organizational Structure

The Forest Science Program includes the Research Branch, which operates within the Forest Stewardship Division, and the Forest Science Sections of the Northern Interior, Southern Interior, and Coast Forest Regions, all of which operate within the Operations Division. The Research Branch Director is responsible for establishing strategic direction for the Program, and for maintaining policies and standards.

The FSP is geographically dispersed, to be responsive to the business and problem-solving needs of the Ministry, reflecting the major differences in ecosystems and forest management concerns throughout the Province (refer to staff locations listed on inside back cover). The regional Forest Science Sections played an instrumental role during 2007/08

Birch syrup production project – Quesnel.

in supporting the operational needs of decision-makers within their respective regions and districts. The Research Branch supported policy development and the needs of various MFR branches in Victoria, and advocated on behalf of the FSP as a whole. Research Branch discipline leaders worked co-operatively with regional Forest Science Sections to develop provincial strategies, undertake joint research projects, develop extension products, and provided advice to clients. Together, the FSP team addressed numerous Ministry initiatives and divisional priorities. (Refer to sidebars, pgs 19, 20, for lists of divisional priorities supported by the FSP.)

In 2007/08, the FSP included the equivalent of 136 full-time positions: 10.5, 18.5, and 17.6 positions were based in the Coast, Northern Interior, and Southern Interior regions, respectively, while 89 positions were based in the Research Branch. Forty percent of Research Branch positions were located in decentralized Ministry facilities such as research stations, regions, and districts.

The following paragraphs briefly describe the responsibilities and activities of each FSP section and region.

Research Branch

The Research Branch provided scientific support and best available information during 2007/08 to the Chief Forester and Deputy Chief Forester and to other branches within the Forest Stewardship Division. In several disciplines, group leaders co-ordinated provincial research and liaised with other branches and clients to support forest stewardship policy and practices. The Research Branch also undertook research and extension in matters of provincial scope, such as Forest Genetics and Stand Development Modelling. The Branch is divided into three sections:

1 Ecology and Earth Sciences

The Ecology and Earth Sciences Section comprises an interdisciplinary team of researchers with expertise in plant ecology, range ecology, soil conservation, silviculture systems, climatology, hydrology, fish and wildlife habitat, geomorphology, and non-timber forest resources.

This Section provided support and leadership, this past year, for many Ministry programs, initiatives, and strategies. Activities included developing best practices to support FRPA implementation through FREP, FFEI, and the MPB Action Plan. Ecology and Earth Sciences researchers also provided technical expertise for Forest Stewardship Division priorities such as Ecosystem-based Management (EBM), sustainable biomass harvesting, coastal second-growth management, MPB management, adaptation to climate change, and management of non-timber forest resources.

2 Forestry and Technical Services

The Forestry and Technical Services Section provides analytical, technical, and administrative support services to FSP sections and regions, other Ministry branches, and the Executive Office. This Section's main research areas are stand development and landscape ecology modelling.

During 2007/08, the Stand Development Modelling group continued refining and developing the various growth and yield decision-support tools it has supplied to the Forest Analysis and Inventory Branch, forest regions and districts, and industry in support of Timber Supply Reviews, habitat supply modelling, and growth and yield programs. The Strategic Analysis group continued this year in producing landscape-level analyses using spatially explicit models and geographic information systems (GISs). The group also provided biometrics expertise on applying statistical methods to research, operations, and policy in support of the MPB Action Plan, FREP, FFEI, landscape-level reforestation strategies, and other Ministry priorities.

Pest control of cone and seed insects.

The Forestry and Technical Services Section in 2007/08 supplied central support services to the Research Branch and regional Forest Sciences Sections. The Analytical Laboratory provided analytical chemistry services to the FSP and a host of other clients. The Laboratory conducted chemical, physical, and biological tests on soil, vegetation, and water samples that contributed to FFEI, FREP, the MPB Action Plan, and the Coastal Forest Action Plan, among other Ministry initiatives.

The Finance and Administration group during 2007/08 co-ordinated Forest Investment Account–Forest Science Program (FIA–FSP) project reporting, and planned and managed financial and human resources for the FSP. The group improved organizational effectiveness by helping recruit and develop future research talent through succession planning and client partnerships.

The Technical Communications group maintained three functions in 2007/08: Library, Production Resources, and Knowledge Management. The Ministry Library offered information services to the MFR and Ministry of Environment in support of corporate initiatives and key Ministry priorities. The Production Resources Unit published quality scientific and technical publications, produced extension materials, and provided consultation services. The Knowledge Management Unit protected the Ministry's long-term investments in research.

3 Forest Genetics

The FSP Forest Genetics Section constitutes the largest forest genetics and tree breeding program in Canada. It operates the Cowichan Lake and Kalamalka Research Stations. This Section undertakes research in a number of areas that attract national and international interest. Tree breeding and genetic improvement research during the year increased understanding of genetic variation in British Columbia's tree species, and helped develop economically and ecologically important traits in some of the main commercial species in the Province. Gene conservation activities for 2007/08 included theoretical research and the development of practical applications for maintaining adaptive genetic variation in all native trees species. Seed transfer and climate-change research concerned genecology and model development used to refine seed transfer guidelines in response to climate change. Various ancillary Forest Genetics Section research projects concerning tree physiology and parent tree genetic evaluation contributed towards employing genetically improved material. Meanwhile, seed and cone pest research facilitated improved management of the Ministry's seed orchards.

Northern Interior Forest Region

The Northern Interior Forest Region's Forest Science Section conducts short-term studies of 1–4 years that address high-priority operational needs, as well as long-term projects, lasting several decades, that monitor forest growth and explore ecologic, hydrologic, and geomorphic processes. Researchers are located in Prince George, Smithers, and Dawson Creek, where they offer expertise in climatology, ecology, geomorphology, hydrology, silviculture, soils, and wildlife habitat ecology.

Researchers during the year provided consulting services to support operational staff in using current scientific knowledge to address management issues such as soil disturbance, terrain stability, tree species selection, and harvesting options for salvaging trees killed by the mountain pine beetle. Training activities ranged from providing informal sessions to individual clients to delivering structured workshops on topics such as soil and riparian monitoring assessment procedures, which support FREP.

Staff in the Region's Forest Science Section also helped address pressing regional and district issues such as managing second-growth resources, implementing and evaluating the *Forest and Range Practices Act* through the Forest and Range Evaluation Program, developing strategies for adapting to climate change, and mitigating the mid-term timber supply falldown caused by the MPB epidemic. The researchers also provided expertise on a case-specific basis for compliance and enforcement concerns, forest stewardship plan reviews, and Ministry initiatives such as the FRPA/FREP values teams, the Future Forest Ecosystems Initiative, Timber Supply Reviews, and Ecosystem-based Management.

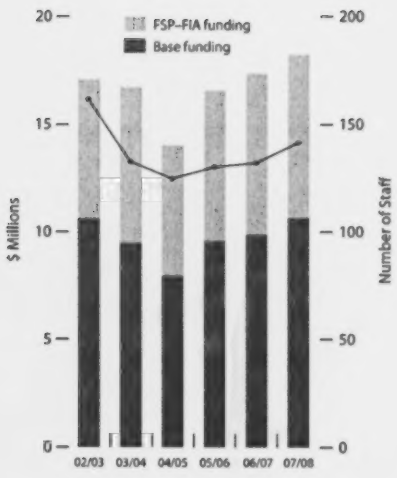


Figure 1 Forest Science Program expenditures and numbers of staff 2002–2008.

Southern Interior Forest Region

The Southern Interior Forest Region's Forest Science Section implements and maintains a range of research projects and installations that improve understanding of the impacts of forest management activities and natural disturbances on the Region's forests and grasslands. Researchers are located in Kamloops, Williams Lake, and Nelson, where they specialize in ecology, geomorphology, hydrology, silviculture systems, soil science, and wildlife habitat ecology.

The Region's Forest Science Section, through consultations and training activities, supported Region and District staff in addressing forest management issues during 2007/08. Section researchers provided expertise on managing dry-belt forests for range, fuel management, and wildlife habitat, and developed tools and training to reduce the hydrologic impacts of the MPB outbreak and associated salvage harvesting. Wildlife and silviculture systems researchers collaborated on giving guidance about harvesting options in mule deer winter range, and provided the scientific foundation for species-at-risk recovery planning and grassland conservation strategies. The Region's researchers were actively involved in developing indicators and monitoring protocols for FREP soils and terrain resource values. The researchers also reviewed forest stewardship plans and provided advice on individual cases to compliance and enforcement staff.

Coast Forest Region

The Coast Forest Region's Forest Science Section employs a multidisciplinary team of researchers who are engaged in applied research, training, and consultation in support of regional and district forest and range operations over some of the most complex and diverse ecosystems in the Province. Staff, located in Nanaimo and Smithers, have expertise in forest ecology, geomorphology, hydrology, silviculture systems, soil science, and wildlife habitat ecology.

Forest Science Section staff focussed on high-priority issues over the year, including those involving FREP resource values such as wildlife, soils, and terrain stability. Researchers also addressed concerns about hydrologic recovery, ecological classification and resilience, species at risk, and effects of variable retention on regeneration. As well, the Region's scientists helped identify potential research needs for the Future Forest Ecosystems Initiative, and were involved in adaptive management initiatives to successfully implement Ecosystem-based Management on the Central and North Coast.

Funding and Expenditures

In 2007/08, the Ministry of Forests and Range Forest Science Program's allocations increased slightly over the previous year, from $16.4 to $17.1 million. Funding for the program came from the FIA–FSP (52%) and Ministry base funds (43%). Ministry base funds covered most essential fixed costs, including most staff salaries and facilities maintenance. Base funds also covered a minimum amount of operating costs.

The Forest Investment Account–Forest Science Program (FIA–FSP) funds most of the Forest Science Program's research projects. The FIA–FSP is administered by PricewaterhouseCoopers through a competitive, proposal-driven process. Researchers with the Ministry's Forest Science Program have continued to successfully acquire FIA–FSP funding for their projects.

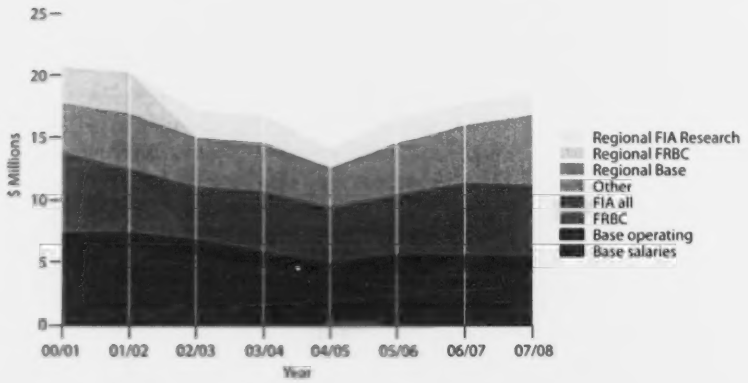


Figure 2 Forest Science Program funding: distribution of funds by funding source, 2000–2008.

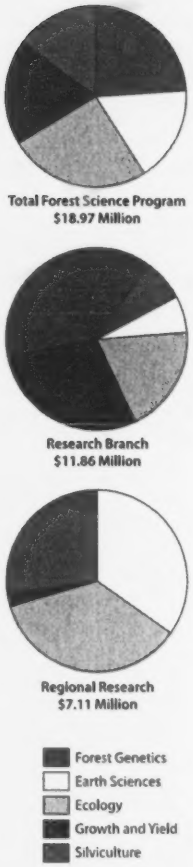
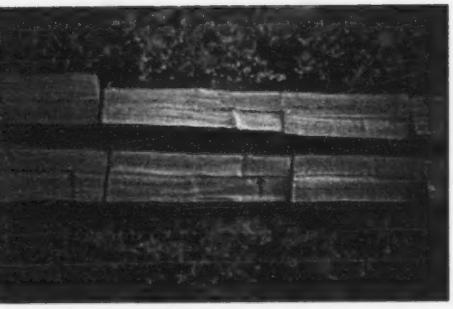


Figure 3 Forest Science Program funding, by discipline. Disciplines for which funding information was collected relate to those reported in this annual report as follows – **Forest Genetics-** Coastal and Interior Tree Breeding, Conservation of Genetic Resources, Ancillary Forest Genetics Research; **Earth Sciences-** Soils, Geomorphology, Hydrology, and Fish Habitat Biology, Climatology; **Ecology-** Ecology, Wildlife Habitat, Range Ecology; **Growth and Yield-** Stand Development Modelling, Landscape Ecology Modelling, Biometrics, Technical and Administrative Support Services; **Silviculture-** Silviculture Systems.



Site productivity – stem analysis.

Forest Science Program Goals for 2007/08

Conduct research to provide knowledge for present and future policies, practices, and standards

FSP research activities were aligned during 2007/08 to specifically meet the Ministry's needs for a scientific basis to inform the development of new policies, practices, and standards. The Program's research emphasis was on supporting the year's current divisional priorities, including implementing FRPA and FREP, progressing in Ecosystem-based Management, and managing MPB impacts. The FSP also initiated research in anticipation of future knowledge needs, most notably stewardship of forest and range resources in the face of climate change. Much of this work was integrated with Ministry initiatives such as the FFEI and the Forest Genetics Council of British Columbia.

Support science-informed policy development

In addition to providing support for internal Ministry policy development, FSP staff participated in many intergovernmental policy and management committees (listed in Appendix 1). The committees were an effective avenue for researchers to bring their scientific expertise to bear on policy formation. For example, researchers helped address FRPA legislation and policy issues by participating in the Joint Management Committee, which develops recommendations for changes to forest practices, legislation, and policy. FSP researchers also developed recommendations for coastal Ecosystem-based Management research priorities through the EBM Working Group. As well, they improved outreach to First Nations groups through the First Nations Forestry Council and the Inter-Agency Non-Timber Forest Resources Committee.

Maintain high scientific standards

FSP researchers maintained their credibility within the scientific community by presenting research results at scientific conferences and in peer-reviewed technical reports and scientific journals. Scientific rigour was ensured by adhering to Ministry standards for research design and reporting, maintaining biometrics expertise within the FSP, and enlisting peer and technical reviews for external and in-house publications. In addition, the FSP depended on project support from its analytical chemistry laboratory, which has achieved high quality-control standards by participating in the National Association for Proficiency Testing and the Wageningen Evaluating Program for Analytical Laboratories international proficiency testing programs. To further enhance the Program's scientific standards, progress was made on implementing a new information management system—FSWorkS—designed to track and provide easy access to information on experimental installations and to other intellectual property.

Facilitate an integrated, co-operative approach to working with the wider forest science community

FSP staff participated on advisory committees associated with research funding agencies to ensure that Ministry research needs were understood and given appropriate priority in funding allocation decisions. Staff also collaborated with federal government and university scientists, as well as industry and consultants. FSP researchers worked with provincial and national interagency organizations, such as the Pacific Climate Impacts Consortium and the Forest Genetics Council of British Columbia, to co-ordinate efforts and share information and technologies.

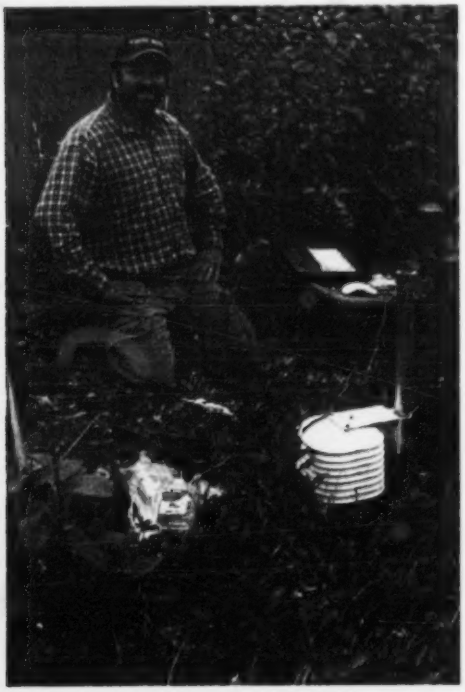
Communicate and extend timely research results and scientific knowledge

FSP researchers provided consultation and extension services, strategic analyses, and operational problem-solving as a means of ensuring that science informed resource management practices. The FSP increased its client outreach during 2007/08 by continually updating the Program's website and producing other communications products. Over the past year, staff delivered 443 extension events and products, and produced 95 peer-reviewed publications. The Ministry Library also maintained a web-accessible database with electronic access to a growing body of scientific literature, and compiled full-text bibliographies on current topics such as the MPB.

Needle response to spacing and thinning.

Client Services

The scope of the FSP's applied research was reflected throughout the year in the diversity of its clients and collaborators (refer to Table 1 on client groups and Appendix 2 on collaborators). Internal clients included the Chief Forester, Ministry Executive, and regional and district managers. FSP researchers also assisted staff in many branches: Revenue, Protection, Range, Forest Practices, Tree Improvement, Resource Tenures and Engineering, and Forest Analysis and Inventory. Other clients within the MFR included regional and district forestry staff, Compliance and Enforcement staff, and BC Timber Sales personnel. The Program's external clients consisted of licensees, resource management consultants, First Nations resource managers, industry associations, private seed orchards and nurseries, university scientists, non-governmental organizations, and the general public.

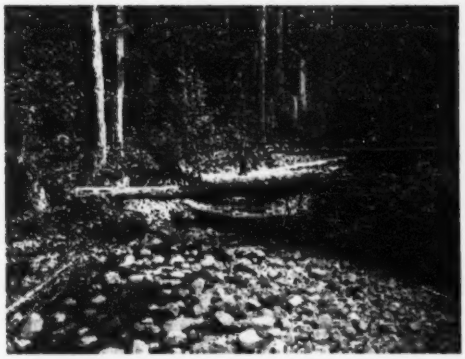


Measuring air and soil temperature and soil water content on disturbed and reclaimed sites helps researchers to better understand the factors affecting seedling survival and growth.

Table 1 Client groups

Ministry of Forests and Range	• Chief Forester's Office and Ministry Executive • Regional Management Teams • Regional and district staff • BC Timber Sales • Forest Analysis and Inventory Branch • Forest Practices Branch • Protection Branch • Range Branch • Resource Tenures and Engineering Branch • Revenue Branch • Tree Improvement Branch • FRPA Forest and Range Evaluation Program
Provincial government	• Integrated Land Management Bureau, Species at Risk Coordination Office • Ministry of Energy, Mines and Petroleum Resources • Ministry of Environment • Ministry of Health • Ministry of Transportation
Federal government	• Canadian Forest Service • Fisheries and Oceans Canada
First Nations government	• First Nations groups • First Nations Forestry Council
Industry and non-governmental organizations	• Coast Region Implementation Team • Community groups • Forest Genetics Council of BC • Forest Nursery Association of BC • Forest Research Extension Partnership (FORREX) • Forest industry • Mining industry • Nursery services • Ranching industry • Universities and colleges • University of British Columbia, Genome BC

The increasingly complex and changing resource stewardship environment meant that client requests to the FSP for new products and technical advice increased over the previous year. Researchers prepared in-house a variety of extension products designed to meet specific client needs. They also worked in collaboration with the Forest Research Extension Partnership (FORREX) to extend scientific information. Extension activities included conducting on-site consultations, leading field tours, developing situational analyses, delivering training courses and workshops, producing Extension Notes, and synthesizing the best available information for practitioners. Many FSP researchers, as recognized leaders in their fields, were also in demand to present papers on their work at national and international conferences.



Fan channel network research.

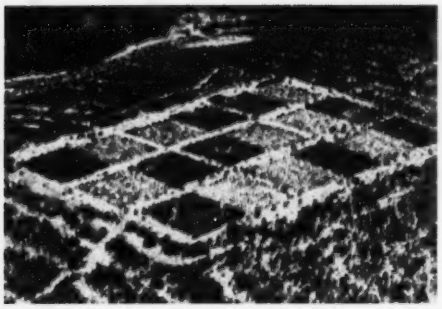
Major Priorities for Forest Science Program Research

The Forest Science Program focussed its research initiatives in 2007/08 on directly addressing the most pressing issues facing forest and range managers. These major issues concerned operational forest management, mountain pine beetle impacts, and adaptation to climate change. Further elaboration on the multidisciplinary research that the FSP applied to the major issues is provided in the accompanying text box.

The following section highlights FSP research activities for each of the three issues listed below.

Operational Management - Research Highlights

- Adjusted timber harvesting strategies to better maintain mule deer winter range in various snowpack zones through participation on the provincial FREP Wildlife Resource Value team.
- Advised on appropriate landscape-level management options for dry, fire-dominated ecosystems, with an emphasis on best practices for ecosystem restoration.
- Supported policy development and implementation of natural disturbance unit guidance applicable to managing seral stage and patch size distribution in northern timber supply areas.
- Furthered the utility of Biogeoclimatic Ecosystem Classification (BEC) by completing detailed BEC mapping, improving district-level BEC maps and tools, and producing improved field guides for areas currently under-represented by the BEC system.
- Summarized scientific information on disturbance history for each BEC zone to assist with the design of landscape management systems that mimic natural disturbance ecology.
- Worked with district and regional staff in piloting a risk assessment procedure for assessing soil, geomorphic, and hydrologic hazards that elevate the risk of erosion and landslides after wildfire. The process focussed on assessing and managing risks, including applying mitigation measures. With its emphasis on protecting public safety and critical public infrastructure, the project contributed to identifying and communicating to stakeholders the risks of slides and erosion.
- Participated in a multi-agency research study on deer browse of western redcedar and yellow-cedar regeneration to address second-growth management options on the Coast.
- Released an enhanced version of Tree and Stand Simulator (TASS) III, with the new capability of projecting forest growth under complex



The Long-Term Soil Productivity site, near Log Lake, will provide baseline information on how soil compaction and organic matter removal affect the future productivity of forests.

A flying squirrel living in a beetle-attacked forest.

silvicultural treatments and harvesting patterns. The model was designed to assist forest managers in evaluating management options for resource planning and timber supply review processes.

- Initiated a multi-site, long-term field trial of orchard seedlots for 16 tree species to assess their climatic and photoperiodic tolerances. Further research was conducted on multi-species adaptation to better understand Class A seedlot productivity responses across a wide climatic and latitudinal range. Results of both these studies will assist in refining species and seedlot selection systems to complement current and future climates.

Mountain Pine Beetle - Research Highlights

- Synthesized current information on stand-level practices that can maintain habitat for species at risk during large-scale timber salvage harvesting of MPB-affected forests.
- Designed risk assessment procedures for wet, inoperable sites and developed solutions to minimize flooding created by accelerated salvage harvesting of MPB-affected forests.
- Identified indicators for assessing watersheds at risk and developed operational salvage strategies for mitigating MPB-related impacts on watersheds.
- Determined the extent and abundance of secondary structure in MPB-affected stands, and assessed the implications for carbon budgets and the impacts on long-term forest productivity.
- Produced science-based information to guide operational foresters in using fertilization and thinning treatments that release growth of repressed lodgepole pine. These silvicultural treatments will help mitigate the mid-term timber supply falldown resulting from the MPB epidemic.
- Participated in a carbon-flux study, in collaboration with the University of British Columbia, the Canadian Forest Service, and the University of Northern British Columbia, that assessed how MPB disturbance changes the forest carbon balance. The results provide information for modelling the impact of MPB on British Columbia's forest carbon balance.
- Modelled the 20-year shelf life of MPB-killed wood to examine log grade changes over time.
- Evaluated genetic variation in lodgepole pine related to MPB resistance and examined the potential mechanisms of that resistance.

Future Forest Ecosystems Initiative: Climate Change - Research Highlights

- Completed the report *Climate Change, Impacts and Adaptation Scenarios*, based upon the most current data available on predicted impacts of climate change.

- Initiated a large-scale field trial that will allow a better understanding of the climatic tolerance of tree species, and populations within species, for the purpose of refining seedlot selection guidelines so that plantations are better adapted to future climates.
- Identified seed selection schemes to maintain forest productivity as climates change.
- Established microclimatic monitoring at the Prince George Tree Improvement Station, which will help predict climate-change impacts on foliar diseases.
- Studied how fertilization of Douglas-fir forests influences carbon uptake.
- Initiated research on the effects of grazing on soil carbon sequestration and storage in rough fescue grasslands.
- Developed an assessment framework to assist managers in evaluating the consequences of climate change for ecosystems vulnerable to invasive plants and associated threats.
- Identified wildlife species that are particularly sensitive to climate change, and gathered baseline data for monitoring species and ecosystems in areas most vulnerable to change.

Interior Douglas fir seeds - geographic patterns of genetic variation.

Scientific Support for Improving Operational Management Practices and Decision-making

The following section highlights some of the consultation and training services provided by FSP researchers in the 2007/08 fiscal year. These examples illustrate the scope of issues addressed, the range of scientific disciplines required to meet those demands, and the impact that FSP scientific expertise has had on the Ministry's ability to conduct its business effectively.

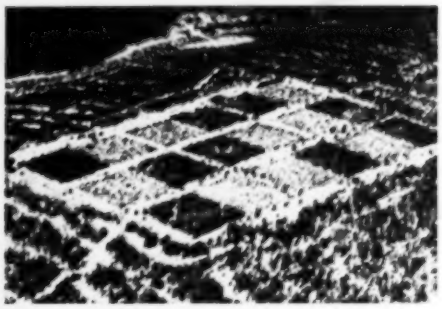
Geomorphology, hydrology, and watershed processes

Consultations with FSP specialists in earth science disciplines typically aimed at reducing potential costs to public and private infrastructure and to human life. Regional consultation services provided by the FSP have included landslide investigations and monitoring, alluvial fan hazard assessments, terrain analysis, slope stability assessments, hazard and risk assessments in post-landslide areas, and control of erosion arising from storms and rain-on-snow events.

Evidence of concentration of overland flows.

Wildlife habitat ecology

Regional wildlife habitat researchers addressed the key issues concerning species-at-risk management, mountain pine beetle habitat impacts, and ungulate winter range provisions for the Ministry's operational programs. Regional researchers were instrumental in providing the scientific foundation for management recommendations to support protection of provincial species at risk, such as mountain caribou, Marbled Murrelet, Spotted Owl, Northern Goshawk, ermine, and tailed frog. Regional wildlife habitat researchers also synthesized the current information on



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Measuring stand structure recovery in coastal forests.

stand-level practices that can maintain habitat structure and attributes during large-scale timber salvage harvesting following MPB devastation.

FSP researchers provided scientific advice on the effects of timber harvesting to maintain mule deer winter range in various snowpack zones. Wildlife habitat research results were incorporated into decision models that enabled the Chief Forester and Regional Management Teams to understand the social, economic, and ecological implications of various management scenarios at multiple scales. Furthermore, research on mule deer and mountain caribou provided the basis for the General Wildlife Measures established under FRPA. These measures now guide forest management throughout the Cariboo-Chilcotin area.

Ecology

Regional research ecologists have provided advice on field application of the BEC system and related management interpretations to an array of clients for over 20 years. This past fiscal year, BEC field training courses were offered to several interagency groups, including the Haida Guardians. In the Southern Interior, research ecologists advised on appropriate landscape-level management options for dry, fire-dominated ecosystems, particularly best practices for ecosystem restoration. Northern Interior ecologists contributed to policy development and implementation of natural disturbance unit guidance for managing seral stage and patch size distribution in northern timber supply areas. On the Coast, ecologists' advice directly supported implementation of Ecosystem-based Management (EBM) and the Coastal Forest Action Plan.

Analyzing soil sample.

Soils

Regional soil scientists developed practical tools for efficiently assessing and monitoring soil disturbance under a variety of conditions. They also assisted in selecting appropriate forestry practices to reduce soil disturbance. In the Northern Interior Region, soil scientists prepared risk assessment procedures that reduce the risks associated with wet, inoperable sites resulting from the MPB epidemic and associated salvage logging. Soil scientists also provided leadership in developing and evaluating monitoring protocols for the FREP soils resource value.

Silviculture systems

Regional silviculture systems researchers gave consultations this past fiscal year to address forest management concerns ranging from regeneration problems to managing coarse woody debris to maintaining biodiversity attributes. Northern Interior researchers provided salvage harvesting options for managing secondary stand structure in MPB-affected areas. In the Coast Region, FSP researchers made recommendations on harvesting and silviculture options to recruit trees, and on enhancing wildlife habitat for Spotted Owls. Researchers on the Coast also supported the Coastal Forest Action Plan by developing operational guidelines for extensive and intensive red alder management regimes.

Scientific Support for the Policy and Management Response to Mountain Pine Beetle

The FSP continued its involvement in one of the most pressing and ongoing challenges facing interior forest managers this past year: developing an effective and appropriate response to British Columbia's mountain pine beetle epidemic. With the environmental, economic, and social impacts of the current outbreak unprecedented, research plays a pivotal role in determining the best management approaches. The FSP was active on many fronts, including providing strategic policy and decision support for implementing the provincial MPB Action Plan. FSP technical expertise was solicited for several policy and technical committees concerned with MPB. Research results directly formed the basis for elements of the MPB Action Plan and the Forests For Tomorrow program.

Many operational technical needs have arisen as a result of the MPB infestation, and these were addressed by FSP researchers from several disciplines. For example, soils and hydrology researchers in the Central Interior resolved licensees' concerns about how to minimize the risks of flooding due to extensive MPB-caused tree mortality and associated accelerated salvage harvesting. The researchers identified watershed, forest cover, and site indicators for assessing watersheds at risk, along with operational salvage strategies for mitigating watershed impacts.

Silviculture researchers provided recommendations in the past year for operational mitigation of the mid-term timber supply falldown caused by the MPB epidemic. Results of long-term research projects revealed relevant silvicultural strategies and appropriate fertilization and thinning options for releasing repressed pine, as well as shaped monitoring protocols for the Forests For Tomorrow program. FSP silvicultural specialists constructed analytical models of complex stand growth to assist the Chief Forester and Regional Management Teams in mitigating the projected mid-term timber supply falldown in forests where sufficient secondary structure remains.

Mountain pine beetle exit hole.

Over the past 30 years, FSP forest genetics researchers have helped identify superior provenances of lodgepole pine for breeding trees that produce greater wood volume or improved resistance to forest pests. Based on this research, MFR and forest licensees in 2007/08 procured "emergency" collections of superior lodgepole pine provenances to assist British Columbia's recovery from the MPB epidemic.

The FSP made significant strides last fiscal year in acquiring new knowledge and making available existing information about managing forests in the wake of the MPB epidemic. Guided by the 2007/08 MPB Research Strategy, FSP scientists from various disciplines established more than 50 research projects to examine the MPB and post-MPB concerns, and associated management responses. The Ministry Library, managed by the FSP, prepared an MPB bibliography containing over 800 citations, many of which are available electronically. A comprehensive list of current projects and extension activities is available at the Forest Science Program MPB research web page www.for.gov.bc.ca/hre/topics/mpb.htm.

The Future Forest Ecosystems Initiative—Scientific Support for the Ministry's Response to Climate Change

Twenty-year-old Douglas-fir adaptation trial at Date Creek, northwest of Smithers, B.C.

The Chief Forester launched the FFEI to assess the vulnerability of British Columbia's forest and range resources to climate change, and identify how to best adapt the Province's forest and range management framework. Due to the complexity of climate change, determining the best management responses requires research with an interdisciplinary approach.

FSP researchers established the scientific basis for the FFEI in their report, *Climate Change, Impacts and Adaptation Scenarios,* which provides the Chief Forester with the most current and accurate information available for understanding the predicted impacts of climate change.

The FFEI utilizes decision-support tools and models to project future climate scenarios and account for potential biogeoclimatic shifts across the Province. In the past year, an interdisciplinary group of forest geneticists, climatologists, and landscape ecology modellers developed sets of high-resolution spatial climate data to use in future scenario projections. These data allowed managers to ascertain the most vulnerable resources and how forests can adapt to climate change.

Climate scenario testing allowed researchers in 2007/08 to predict vegetation shifts, evaluate seed planting zones, estimate precipitation trends, and link precipitation estimates with geomorphic events. Forest geneticists studied the relationship between adaptive genetic and ecological variation. Their model outputs from these investigations helped revise seed selection schemes to maintain forest productivity.

A baseline from which to assess future change is crucial to fully understanding the effects of climate change on natural resources. To establish that baseline, FSP forest ecologists and wildlife habitat scientists initiated new field research to monitor species and ecosystems in the areas most vulnerable to changes in climate: the transitional areas between biogeoclimatic units, such as the forest–grassland or alpine–parkland interfaces. Ecologists expected these areas to exhibit particularly apparent biological changes because the plant communities have a narrower tolerance to shifts in temperature, precipitation, or length of growing season. Wildlife ecologists have also identified species, such as the tailed frog, that are especially sensitive to environmental change and will therefore serve as important indicators of any habitat transformations.

As scientists attempt to address the uncertainty and management implications associated with climate change, the value of long-term research in revealing climatic trends becomes especially apparent. The Long-Term Soil Productivity study, for example, continued to provide baseline information concerning the impacts of soil compaction and organic matter removal on soil and forest productivity across several ecosystems. Over time, long-term research such as this will enhance the Ministry's ability to detect and manage for climate change.

Achievements: Scientific Support for Forest Management Policies, Decision-making, and Practices 2007/08

The Forest Science Program made significant contributions during 2007/08 to forest and range management in British Columbia. The Program's researchers assisted in addressing provincial policies, regional issues, and district operational needs.

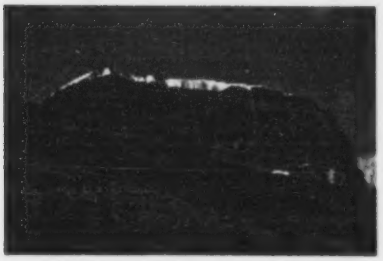
The scientific process—anticipating and asking applied forest management questions, then designing field experiments to study and model the response of interrelated variables, then analyzing the results to reveal new insights—generates a vast body of knowledge and experience across the full spectrum of forest management issues. Considerable value derives from applying this knowledge to emerging complex forest policy and management issues. FSP researchers are highly skilled at addressing knowledge gaps, and particularly adept at the challenging tasks of translating science to policy and subsequently translating policy to practice.

When faced with high risk and uncertainty, forest managers and decision-makers often require immediate assistance based upon the best available science. FSP specialists are well-positioned to respond. Further data gathering, testing, and analysis provides essential information to verify or modify the initial advice, and ultimately contribute to an improved understanding of the long-term impacts of management decisions.

The Ministry relies on FSP researchers to provide credible, scientific knowledge, expertise, and decision-support tools for implementing the *Forest and Range Practices Act* (FRPA), and for enabling appropriate responses to complex issues such as climate change. FSP researchers have provided important scientific and technical support for new initiatives, policy development, and operational guidance (refer to text boxes on divisional priorities supported by the FSP). Many do so through their active involvement in the provincial and regional MFR committees as well as the interagency management advisory committees listed in Appendix 1.

Regional researchers responded to a considerable number of requests during 2007/08 from regional, district, and BC Timber Sales (BCTS) staff for scientific advice on day-to-day forest and range management concerns. In some regions, researchers spent as much time providing consultation and training as they did conducting scientific research.

The FSP contributed substantially in several different realms to developing and implementing FRPA. One emphasis for FSP researchers this past year was in building FREP methods and protocols, which they did collaboratively by actively participating on the soil, fish/riparian, biodiversity, and forage resource values teams. As an example, FSP soil scientists led in the preparation of FREP soil indicators and monitoring protocols, and developed and piloted soil sampling methodologies. They also delivered extensive soils training to district and regional staff.



Alpine parkland, alpine, and the Seven Sisters in the background.

Operations Division 07/08 Priorities* Supported by the Forest Science Program

- Organizational Effectiveness
- Stewardship Concerns:
  - Ecosystem-based Management
  - Climate Change
  - Land Use Planning
  - Forests for Tomorrow
  - Future Forest Ecosystems Initiative
  - Silviculture Delivery
- Mountain Pine Beetle Strategies for Timber Disposition
- Forest Worker Safety
- FRPA and FREP Implementation
- Range Program Inventories
- Protection Program
- Compliance and Enforcement
- Tenures and Revenue Program
- First Nations

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Forest Stewardship Division 07/08 Priorities* Supported by the Forest Science Program

- Organizational Effectiveness
- Future Forest Ecosystems Initiative

Forest Stewardship Management Issues

- Future Forest Strategies
- Coast Revitalization Strategy
- Gene Resource Management Challenge Dialogue
- National Initiatives—Canadian Council of Forest Ministers, National Forest Strategy

Mountain Pine Beetle Initiatives

- FRPA Implementation
- Forests For Tomorrow
- Forest Stewardship Issues:
  - Partial Harvesting
  - Growth and Yield
  - Inventory

Forest Monitoring

- State of the Forests
- Forest Health–Timber Supply Review
- Strategic Review of Long-term Research Installations
- Continuing Forest Stewardship Education
- Data Systems and Information Management

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Watershed research specialists also supported FRPA implementation in 2007/08 by providing advice on riparian practices involving stream crossings and fish barriers. Additionally, these researchers gave scientific and technical assistance to the district staff responsible for conducting the resource stewardship monitoring fish/riparian survey protocols.

The high demand within the MFR for technical expertise at both the policy and operational levels has required FSP researchers to find an effective balance between conducting research, supporting policy development, and consulting on operational issues. In addition to dealing with current management challenges, FSP researchers must also have an eye to the future, so that they can design and implement research today that will generate solutions for new and emerging issues.

Achievements: Research and Extension 2007/08

The FSP continued and initiated during 2007/08 numerous scientific research and extension projects that applied various natural science disciplines to pressing questions concerning forest or range management. Presented here are brief descriptions of each discipline's areas of focus, along with some highlights from the projects conducted during the year. Information on research carried out by both branch and regional FSP staff is combined for each discipline.

Many of the research projects under way were interdisciplinary, and entailed collaboration among the Research Branch and regional researchers, and also with other agencies and academic institutions (listed in Appendix 2). The Program's website www.for.gov.bc/hre provides greater detail on its 2007/08 research activities.

1 Ecology

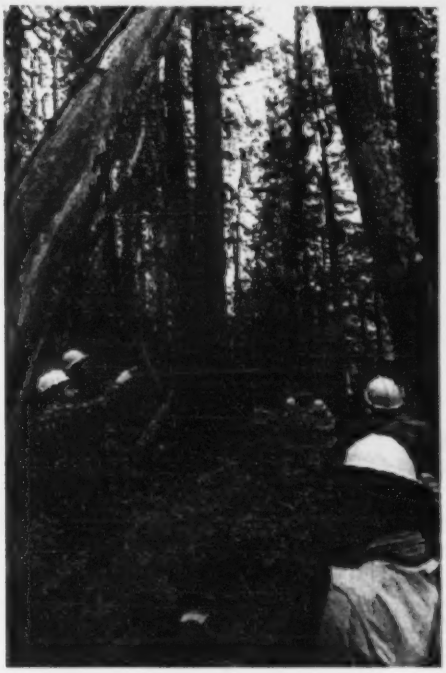
Biogeoclimatic Ecosystem Classification (BEC) is a comprehensive, multi-level ecological classification system that forms the scientific foundation for sustainable resource management in British Columbia. Within the BEC program, FSP researchers classify and describe forest and range ecosystems, and map ecosystem distributions throughout the Province. Additionally, ecology researchers study the impacts of management activities on forest and range values.

Ecology researchers continued in 2007/08 to refine the BEC system and develop new, ecologically based decision-making tools and management applications for use at both the operational and strategic-planning levels. Ecology researchers also provided technical advice to Ministry staff on ecological restoration, tree species selection, climate change and adaptation, site productivity relationships, and fire and pest management.

During the past year, BEC research addressed understanding natural disturbance at multiple scales; maintaining ecosystem integrity and function in the managed forest landscape; evaluating forest and range practices on plant community dynamics, forage production, and tree regeneration and productivity; and documenting and modelling ecosystem changes, including recovery rates over time. Other projects concentrated on implementing Ecosystem-based Management (EBM), mimicking natural disturbance regimes, and examining variability in old-growth stand structure and dynamics.

Ecology – Research and Extension Highlights

- Completed detailed BEC mapping for large portions of the Province, and improved district-level BEC maps and tools. These tools support improved stand-level forest management prescriptions, and Terrestrial and Predictive Ecosystem Mapping.
- Developed more accurate and cost-effective computer applications for producing predictive ecological maps.
- Produced improved field guides for ecosystems and geographical areas currently under-represented by the BEC system, such as alpine and subalpine zones, northern boreal forests, the Queen Charlotte Islands ecosystems, and Garry oak plant communities.
- Delivered training to Haida Gwaii First Nation members in forest ecology, and collaborated with them in collecting ecological data on the Queen Charlotte Islands for a revised BEC guidebook.
- Compiled natural disturbance data derived from historical and contemporary maps of wildfire and insect outbreaks, and summarized the scientific knowledge of disturbance history for each BEC zone. The information gathered aids resource managers in developing sustainable practices that better emulate natural disturbances, as well as informs ecological restoration activities.
- Developed models for analyzing the spatial distribution of MPB outbreaks in relation to climate and stand characteristics. These models help resource managers evaluate forest management and ecological restoration options.
- Studied re-establishment of old-growth attributes in second-growth stands and developed guidelines to assist forest practitioners with implementing Ecosystem-based Management.
- Initiated a project to help define requirements for climate-based tree species selection.
- Produced improved Site Index – Biogeoclimatic Ecosystem Classification (SIBEC) estimates that are useful for both timber supply review and silvicultural decision-making.



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Forest Stewardship Division 07/08 Priorities* Supported by the Forest Science Program

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- Data Systems and Information Management

* *British Columbia Ministry of Forests and Range, Forest Stewardship Division. 2007. Divisional priorities for fiscal 2007/08. Victoria, B.C.*

Watershed research specialists also supported FRPA implementation in 2007/08 by providing advice on riparian practices involving stream crossings and fish barriers. Additionally, these researchers gave scientific and technical assistance to the district staff responsible for conducting the resource stewardship monitoring fish/riparian survey protocols.

The high demand within the MFR for technical expertise at both the policy and operational levels has required FSP researchers to find an effective balance between conducting research, supporting policy development, and consulting on operational issues. In addition to dealing with current management challenges, FSP researchers must also have an eye to the future, so that they can design and implement research today that will generate solutions for new and emerging issues.

Achievements: Research and Extension 2007/08

The FSP continued and initiated during 2007/08 numerous scientific research and extension projects that applied various natural science disciplines to pressing questions concerning forest or range management. Presented here are brief descriptions of each discipline's areas of focus, along with some highlights from the projects conducted during the year. Information on research carried out by both branch and regional FSP staff is combined for each discipline.

Many of the research projects under way were interdisciplinary, and entailed collaboration among the Research Branch and regional researchers, and also with other agencies and academic institutions (listed in Appendix 2). The Program's website www.for.gov.bc/hre provides greater detail on its 2007/08 research activities.

1 Ecology

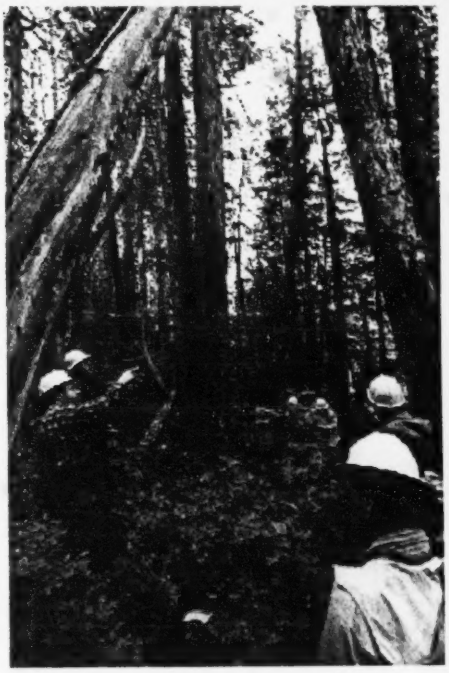
Biogeoclimatic Ecosystem Classification (BEC) is a comprehensive, multi-level ecological classification system that forms the scientific foundation for sustainable resource management in British Columbia. Within the BEC program, FSP researchers classify and describe forest and range ecosystems, and map ecosystem distributions throughout the Province. Additionally, ecology researchers study the impacts of management activities on forest and range values.

Ecology researchers continued in 2007/08 to refine the BEC system and develop new, ecologically based decision-making tools and management applications for use at both the operational and strategic-planning levels. Ecology researchers also provided technical advice to Ministry staff on ecological restoration, tree species selection, climate change and adaptation, site productivity relationships, and fire and pest management.

During the past year, BEC research addressed understanding natural disturbance at multiple scales; maintaining ecosystem integrity and function in the managed forest landscape; evaluating forest and range practices on plant community dynamics, forage production, and tree regeneration and productivity; and documenting and modelling ecosystem changes, including recovery rates over time. Other projects concentrated on implementing Ecosystem-based Management (EBM), mimicking natural disturbance regimes, and examining variability in old-growth stand structure and dynamics.

Ecology – Research and Extension Highlights

- Completed detailed BEC mapping for large portions of the Province, and improved district-level BEC maps and tools. These tools support improved stand-level forest management prescriptions, and Terrestrial and Predictive Ecosystem Mapping.
- Developed more accurate and cost-effective computer applications for producing predictive ecological maps.
- Produced improved field guides for ecosystems and geographical areas currently under-represented by the BEC system, such as alpine and subalpine zones, northern boreal forests, the Queen Charlotte Islands ecosystems, and Garry oak plant communities.
- Delivered training to Haida Gwaii First Nation members in forest ecology, and collaborated with them in collecting ecological data on the Queen Charlotte Islands for a revised BEC guidebook.
- Compiled natural disturbance data derived from historical and contemporary maps of wildfire and insect outbreaks, and summarized the scientific knowledge of disturbance history for each BEC zone. The information gathered aids resource managers in developing sustainable practices that better emulate natural disturbances, as well as informs ecological restoration activities.
- Developed models for analyzing the spatial distribution of MPB outbreaks in relation to climate and stand characteristics. These models help resource managers evaluate forest management and ecological restoration options.
- Studied re-establishment of old-growth attributes in second-growth stands and developed guidelines to assist forest practitioners with implementing Ecosystem-based Management.
- Initiated a project to help define requirements for climate-based tree species selection.
- Produced improved Site Index – Biogeoclimatic Ecosystem Classification (SIBEC) estimates that are useful for both timber supply review and silvicultural decision-making.



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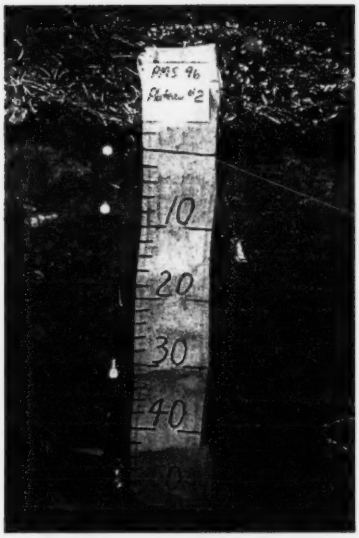


Soil scientists are providing technical advice for the workshop "Scientific Foundation for Sustainable Forest Biomass Harvesting Guidelines and Policy," to share what is known about the impacts of biomass removals on forest ecosystems and to identify research priorities.

2 Soils

Soil science research in the FSP focusses on maintaining soil productivity and hydrologic functioning, and on rehabilitating degraded soils. In doing so, the soils research program has provided the scientific foundation for the FRPA/FREP soils resource value. FSP soil scientists led the development and assessment of new FREP monitoring tools and protocols, and provided training to support FREP implementation.

Soil studies in 2007/08 assessed the effects of nutrient deficiencies and intensive fertilization regimes on soil biology and nutrient cycling in plantations; the effects of silviculture systems and site preparation treatments on tree regeneration, soil productivity, and nutrient cycling; and the interaction between soils and watershed processes, including post-wildfire erosion. Results from soil research were applied to improving existing soil conservation strategies and techniques, and to advising managers on methods that minimize the impact of land management practices. Soil scientists also contributed to refining understanding of the relationship between site index and BEC site unit.

Soils – Research and Extension Highlights

- Led the Soils Landscape Effectiveness Evaluation pilot project for FREP.
- Developed rapid field tests and cost-effective indicators of soil physical condition to help Compliance and Enforcement (C&E) staff evaluate licensee compliance with FRPA.
- Assisted in evaluating and improving FREP protocols for the soils resource value.
- Developed FREP criteria for evaluating stumping as a site preparation technique in areas susceptible to root rot disease.
- Developed operational watershed risk assessment indicators and procedures to predict the effects of MPB infestation and salvage harvesting operations on soils and hydrology.
- Produced a training DVD on soil conservation and management to assist BC Timber Sales in maintaining forest certification.
- Conducted a pilot project to improve the cost-effectiveness of soil monitoring by using digital imagery and GIS software.
- Developed soil disturbance survey methods, analyses, and improvements to support district C&E and BCTS business needs.
- Worked with district and regional staff in piloting a risk assessment procedure for assessing soil, geomorphic, and hydrologic hazards that elevate the risk of erosion and landslides after wildfire. The project focussed on assessing and managing risks to public safety and critical public infrastructure, and helped identify and communicate the risks to stakeholders.

3 Geomorphology, Watershed Hydrology, and Fish Habitat Biology

FSP researchers in these three closely related disciplines collectively examine the effects of forestry and other land use practices on hydrologic and geomorphic processes.

Geomorphology researchers during the past year focussed on improving scientific understanding of landslides and stream channel processes. Their research on landslides, alluvial fan management, and the role of woody debris in streams has shed light on the linkages between hillslopes, channels, and fish habitat. Also in 2007, geomorphologists conducted terrain mapping and stability assessments, as well as Coastal Watershed Assessment Procedures for regional, district, and BCTS staff. Researchers also investigated landslide and erosion incidents to support compliance and enforcement of FRPA. Furthermore, they assisted in developing local management guidelines and in building hazard and risk assessment tools for operational planning.

Alluvial fans tour – Rutherford Creek.

In 2007/08, hydrology researchers examined the effects of forestry activities on fish habitat and fish in various biophysical conditions and forest types; stream channel morphology; and watershed hydrology, including both streamflow and groundwater regimes. Researchers continued to investigate the long-term impacts of harvesting within a coastal drainage at the Carnation Creek research installation.

The geomorphology, hydrology, and watershed sciences specialists provided advice and training to BCTS and district staff on FRPA implementation and forestry operations. Topics included watershed and landslide assessments, and design criteria for stream crossings. Research facilitated the development of best practices for sustaining riparian conditions, protecting fishery resources, restoring watershed function, and maintaining water quality and quantity.

Geomorphology, Watershed Hydrology, and Fish Habitat Biology – Research and Extension Highlights

- Validated the FREP Water Quality Effectiveness Evaluation procedure for the Coast, enabling its application in Resource Stewardship Monitoring by district stewardship staff.
- Developed a web-based training tool for the Forest Practices Branch on how fire and riparian zones are affected by the MPB and salvage logging.
- Published Extension Note 87, *A Summary of Climate Change Effects on Watershed Hydrology*, on the hydrology of coastal British Columbia. This publication, aimed at a broad audience of non-technical readers, increase awareness and provide general forest planning recommendations.
- Assessed overall hydrologic conditions to assist BCTS with forest stewardship planning in the Tsitika River sub-basin.

Projected changes in temperature and precipitation will effect the magnitude and frequency of disturbances.

- Researched road construction on the Coast's unstable slopes that are covered by organic soils to promote resource managers' awareness of the complex situation, and to provide operational guidelines for road construction in similar site conditions.

- Conducted a four-day provincial field tour for international specialists and practitioners attending the Alluvial Fan Conference. The field tour brought international attention to MFR fan research and management. FSP hydrologists and geomorphologists also gained an international perspective on fan processes and management.

- Contributed to workshops, made numerous presentations, and completed Extension Note 88, *Mountain Pine Beetle, Forest Practices, and Watershed Management*, describing the effects of MPB-related forest mortality on hydrologic processes and watershed response. A variety of clients, including regional and inter-agency management teams, First Nations, industry, students, and public groups, made use of these FSP extension initiatives.

- Developed assessment tools for addressing wet ground conditions associated with the MPB epidemic and salvage logging.

- Led a workshop, followed by a field tour, summarizing 23 years of research into the effects of forest harvesting on stand-scale hydrologic processes, streamflow, water quality, channel morphology and aquatic habitat at Upper Penticton Creek. The events, organized by the FSP in collaboration with FORREX, were attended by people from government and industry, as well as by interested citizens.

- Initiated a project to assess the use of aerial photography for sampling secondary structure in lodgepole pine stands. This application could significantly reduce inventory costs for licensees and Ministry staff.

- Synthesized current information on hydrologic processes for the *Compendium of Forest Hydrology and Geomorphology in British Columbia*. This publication is a scientific information source intended for resource professionals, technicians, forest and water licensees, planners, academics, and stream stewards to reference for preparing policy, plans, and training; for improving forest management practices; and for maintaining and protecting water-related values.

- Updated a searchable database on Fish and Forestry Interactions in British Columbia comprising 40 years of fish–forestry research, knowledge, and investment, which was assembled for researchers, students, forest resource professionals, and managers.

- Finalized a Licence of Occupation and working agreement with the Huu Ay Aht First Nation at the Carnation Creek research installation. This agreement represents the First Nation's endorsement of the research project, allowing it to continue and ensuring its integrity. The agreement also formalized Huu Ay Aht membership on the project's Technical Working Group. Additionally, FSP researchers explored with the First Nation ways to collaborate on studies and share data.

- Tested, in collaboration with the Forest Analysis and Inventory Branch,

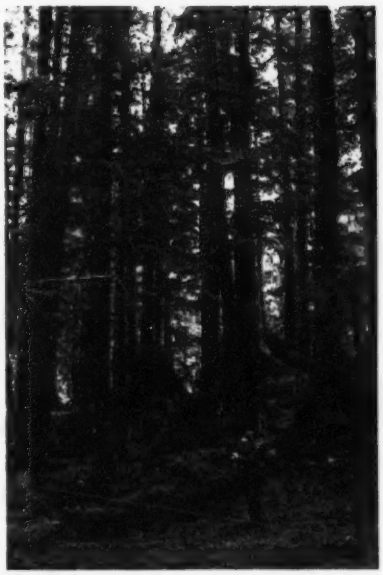
the application of high-resolution optical satellite imagery for detecting landslides and for assessing features at stand and landscape levels.

4 Silviculture Systems

Silviculture systems research examines the utility of silviculture systems for meeting various management objectives while sustaining resource values such as water, soils, timber, biodiversity, and wildlife habitat. Silviculture systems research includes both short- and long-term interdisciplinary field experiments as well as retrospective studies. From this work, FSP silviculture systems researchers during 2007/08 provided forest managers with tools and information to make sound resource management decisions based on understanding the consequences and trade-offs resulting from applying different silvicultural strategies in managed forests.

In the past year, FSP silviculture systems researchers conducted a wide array of investigations, ranging from early stand development to old-growth habitat features. They examined the impacts of silvicultural practices such as partial cutting, fertilization, planting density, and thinning on characteristics of tree and stand productivity, windfirmness, stand composition and structure, stand development and dynamics, soil microbial and faunal communities, and non-timber forest values. Silviculturists also studied early stand development following site preparation, and after brushing and weeding. They developed treatment standards for thinning and fertilizing stands. The effects of stand regeneration and management on old-growth forest attributes were also investigated to improve management of second-growth stands.

Research into silviculture furthermore attended to several major forestry issues affecting the Province. For instance, to enhance understanding of caribou habitat management options, a study examined lichen ecology in old-growth and managed forests. Speeding recovery from the MPB infestation was addressed through evaluations of advanced regeneration and residual tree development in MPB-attacked stands, and with assessments of rehabilitation treatments for increasing productivity in repressed lodgepole pine stands. Silviculture systems researchers also supported the Coastal Forest Action Plan by modelling growth of complex stands using empirical studies, and by monitoring the long-term effects of various red alder management regimes.

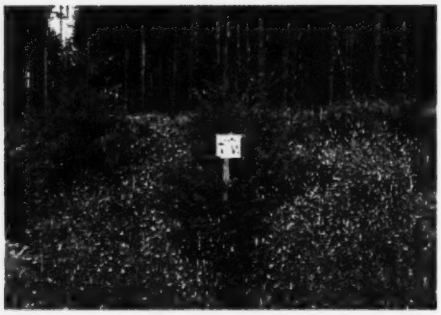


Examining windfirmness, stand composition and structure, stand development and dynamics, soil microbial and faunal communities, and non-timber forest values.

Silvculture Systems – Research and Extension Highlights

- **Continued investigations, in partnership with BCTS, for the Silviculture Systems for Ecosystem Management project in the Sayward Forest (STEMS). This multidisciplinary experiment will enhance understanding of forest productivity, economics, and public perceptions by comparing the trade-offs between seven different silviculture systems or extended rotation treatments in coastal forests.**
- **Summarized and presented research findings on the feasibility of using natural regeneration for reforesting high-elevation fir–spruce stands**

STEMS - clearcut with reserve treatment immediately after harvest.



STEMS - clearcut with reserve treatment five years after harvest.

after logging in south-central British Columbia. The research results are relevant for forest managers, planners, and contractors working with government and licensees, as well as for the international scientific community.

- Conducted scheduled re-measurements of long-term stand management trials to validate data for provincial growth and yield models that support timber supply analysis, silvicultural prescriptions, and investment decisions. This information will enable forest managers to improve treatment response estimates.
- Determined the extent and abundance of secondary structure in stands heavily damaged by MPB, and assessed the implications for carbon budgets, and the impacts on mid-term timber supply.
- Provided recommendations to the Chief Forester on guiding management of poor- and low-productivity cedar–hemlock stands on the Coast.
- Co-authored, with professors at Oregon State University and the University of Quebec, a book entitled *A Critique of Silviculture: Managing Complexity*, which will be published by Island Press in late 2008. The book brings together new ideas and findings in ecology and complexity science to set the foundation for a fresh approach to silviculture, one that manages forests as complex adaptive systems. Those involved with forestry, silviculture, forest ecology, or managing forest ecosystems are the book's intended audience.
- Improved understanding of stand- and landscape-level boreal forest dynamics following disturbance. Forest professionals working in government, industry, and consulting will be able to use this information for forest stewardship planning.
- Developed operational guidelines for modifying timber harvesting in mountain caribou habitat. The guidelines were incorporated into the Species at Risk Recovery Implementation Plan.
- Provided information to support the Spotted Owl Habitat Team's preparation of guidelines for using alternative harvesting systems and silvicultural treatments to develop and enhance Spotted Owl habitat.
- Conducted a tour and produced an Extension Note for operational foresters on the early results of fertilization and thinning treatments to release repressed lodgepole pine. This research will contribute to mitigating mid-term timber supply falldown.
- Published *Biology, Ecology, and Management of Western Hemlock Dwarf Mistletoe in Coastal British Columbia: A Synthesis of the Literature* in conjunction with the U.S. Forest Service, and made the information synthesis available to BCTS silviculturists, licensee foresters and field staff, and forestry consultants.
- Determined relationships between site productivity and BEC site series for alder, birch, and maple to support Coastal Forest Action Plan goals.

5 Wildlife Habitat

Wildlife habitat research supports forest stewardship, land use planning, and implementation of species-at-risk recovery plans. FSP research in this field also addresses current Ministry priorities such as FRPA, the FFEI, and EBM on the Coast.

In the past year, wildlife habitat researchers examined the impacts of forest management practices on wildlife species and habitats in order to develop effective integrated management strategies. Research focussed on wildlife species, including several species at risk, that are particularly sensitive to forest management activities at the stand and landscape levels. These investigations addressed habitat selection and use, population dynamics, and mortality factors.

In 2007/08, habitat impacts resulting from the MPB epidemic were evaluated, and options were examined for protecting critical habitat while optimizing forest management objectives. Climate-change adaptation strategies were proposed for vulnerable wildlife species. Research was initiated to develop analytical and decision-making tools to assess the implications of various forest management scenarios on habitat supply.

Investigating grizzly bear ecology.

Wildlife Habitat – Research and Extension Highlights

- Developed methods to model current and future habitat supply for key wildlife species affected by large-scale lodgepole pine mortality and road development associated with salvage harvesting.
- Conducted a pilot study to evaluate arthropods as reliable indicators of impacts on biodiversity from forest management or climate change, by correlating the organisms with stand-level structural attributes.
- Developed techniques for evaluating resource management decisions in situations where the potential exists for irreversible consequences, such as the extirpation of a caribou population.
- Conducted scenario analyses of potential future landscape changes and caribou population responses aimed at enhancing the resilience of the Tweedsmuir–Entiako caribou population to disturbances such as the MPB outbreak and climate change. This work, carried out in partnership with the Ministry of Environment and the Nature Conservancy, will lead to a better understanding of wildlife range shifts, changes in habitat availability, and connectivity between currently occupied areas and possible future suitable habitat under a range of MPB and climate-change scenarios.
- Developed an innovative decision-support framework, using the Spotted Owl as a case study, that integrates science with policy to solve complex conservation and land use problems.
- Tested Marbled Murrelet habitat quality classification methods using air photo interpretation and low-level aerial surveys. The knowledge gained was integrated into species-at-risk recovery planning.
- Documented that partial cutting of caribou habitat can maintain forage

lichen biomass in residual trees, and can maintain bird communities typical of mature to older lodgepole pine forests. These research results were incorporated into FRPA General Wildlife Measures that guide forest management over tens of thousands of hectares.

Stand-scale hydrologic change associated with MPB will depend on the percentage of overstorey that has been killed.

6 Climatology

Climatology researchers aim to improve understanding of how climate influences forest and range management. In 2007/08, climatologists focussed on process-oriented studies involving energy, water, and carbon balances in forested ecosystems, and forest microclimate influences on plant growth and reforestation efforts. Researchers explored the effects of large-scale disturbances and climate change on forest management activities. They also evaluated the effects of climatic variability and trends on a variety of natural disturbance processes such as landslides, and agents such as forest pests. Climatologists have developed tools and management options to mitigate the effects of climate on forest and range ecosystems. Additionally, FSP researchers played a key supporting role for the FFEI.

Climatology – Research and Extension Highlights

- Participated in two carbon flux studies, one assessing how MPB disturbance is changing the forest carbon balance, and another investigating how fertilization of Douglas-fir forests influences carbon uptake. This research is part of a national research network that provides information to policy-makers on the long-term impacts of issues such as climate change.
- Synthesized 12 years of baseline data from the Upper Penticton Creek Watershed Experiment to address public and forest managers' concerns about the sustainability of the water supply in British Columbia's dry south-central Interior.
- Established microclimatic monitoring at the Prince George Tree Improvement Station to assist in interpreting climatic impacts on foliar diseases.
- Established permafrost monitoring equipment in northeastern British Columbia to address resource management challenges associated with potential climate changes.

7 Range Ecology

Range ecologists facilitate integration of range management activities with other resource uses, and ensure that standards and guidelines for range practices remain current, effective, and science-based. Range research supports the interagency Invasive Plant Strategy, the FFEI, and corporate range stewardship priorities. In the past year, range ecology researchers focussed on understanding the ecology of range ecosystems and the influences of range management and climate change. Researchers investigated climate-change impacts on soil carbon sequestration and

on invasive plants. In addition, range ecologists examined understorey succession and ecological processes following ecosystem restoration of fire-maintained, dry-forest stands, and developed indicators and monitoring methods for range managers to assess range health.

Range Ecology – Research and Extension Highlights

- Initiated a project researching the effects of grazing management practices on soil carbon sequestration and storage in grasslands. The results will augment current carbon models, as well as support range managers in developing more carbon-sensitive practices.
- Developed an assessment framework to assist managers in evaluating the effects of climate change on invasive plants and associated threats to vulnerable ecosystems.
- Examined the roles of grazing, climate change, and overstorey trees in the establishment of conifers in dry-forest ecosystems and the forest–grassland ecotone. From this research, range managers will be better equipped to develop effective restoration plans, resolve range–wildlife conflicts, and confidently manage fuel loading.
- Completed research on the effects of cattle grazing on soil compaction and tree growth on rehabilitated landings. This study identified soil and vegetation indicators for evaluating the compatibility of cattle grazing and tree growth on sensitive sites.
- Studied the use of biosolids for restoring degraded native grasslands by amending soils and accelerating successional processes. This investigation provided critical foundation information on the ecological effects of applying biosolids to native plant communities.

From this research range managers will be better equipped to develop effective restoration plans, resolve range-wildlife conflicts, and confidently manage fuel loading.

8 Stand Development Modelling

The FSP Stand Development Modelling group constructs reliable growth and yield decision-support tools. Information generated by stand modelling is used to develop and improve forest management and policy, support forest and range research, and maintain a sustainable timber supply.

In 2007/08, growth and yield models were validated and calibrated against independent data to ensure the accuracy and precision of models for timber supply analysis and allowable annual cut determinations. The program also worked at increasing the scope of models to include additional species, a broader range of local growing conditions, and factors that affect yield, particularly in the shift to second-growth harvesting. Another line of research entailed refining models to incorporate new capabilities and information on such variables as hardwoods, mixedwoods, windthrow, and light–moisture interactions.

The group served both internal clients, primarily the MFR's Forest Practices and Forest Analysis and Inventory Branches, and external client groups including major licensees, the Canadian Forest Service, and universities.

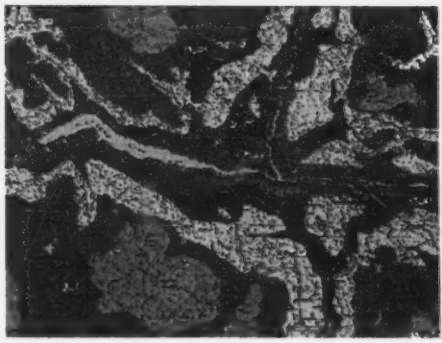
Forest managers evaluate the growth, yield, dynamics, and carbon sequestration effects of managing hardwoods and broadleaf–conifer mixedwoods.

Stand Development – Research and Extension Highlights

- Released an improved version of the Tree and Stand Simulator (TASS) III, which was designed to assist in managing complex stands. The enhanced model allows users to project forest growth under complex silvicultural treatments and harvesting patterns.
- Collected and incorporated growth and yield data for additional tree species, such as red alder and trembling aspen, into TASS. This provided information that allows forest managers and silviculturists to evaluate the growth, yield, dynamics, and carbon sequestration effects of managing hardwoods and broadleaf–conifer mixedwoods. Inclusion of coastal hardwood species in tree growth models supports the Coastal Forest Action Plan goal of encouraging hardwood harvesting and planting.
- Expanded existing models to extend their scope of application to optimum light conditions, non-timber forest resources management, range forage, genetic worth (percent elevated gain), and economic impacts of forest pest outbreaks.
- Modelled response of residual trees and regeneration following MPB attack in thinned lodgepole pine stands to assist in developing management options for mitigating the mid-term timber supply falldown.
- Collaborated with the U.K. Forestry Commission in Edinburgh, Scotland on incorporating their windthrow model, ForestGALES, into TASS, and also with the University of British Columbia in adapting ForestGALES to British Columbia conditions. This project assists the Province's forest managers in evaluating the impacts of windthrow on growth, yield, and dynamics following disturbances such as partial harvesting.
- Assembled data for tools that support the effective application of silvicultural investments. Activities involved conducting scheduled remeasurements and analyzing long-term research trials on operational site preparation and vegetation management prescriptions for custom TASS model projections. This work will enable forest managers and silviculturists to evaluate the effects of site preparation and vegetation management treatments by projecting tree growth and dynamics of management activities to the time when stands are expected to be harvested.
- Completed field research on light dynamics, tree growth, and competition among lodgepole pine, white spruce, and aspen in boreal and sub-boreal mixedwood stands. Also collected baseline microclimate data for future model development of partial-cutting regimes in several forest types. These data provide the basic information required to develop mixedwood modelling capacity and support mixedwood management policy. Eventually, forest managers and silviculturists can use the results to evaluate the growth, yield, dynamics, and carbon sequestration effects of managing boreal and sub-boreal mixedwoods.

9 Landscape Ecology Modelling

The FSP Landscape Ecology Modelling program provides essential support for the provincial BEC program and develops models to aid MFR staff in making strategic-level forest management decisions. In the past year, modellers improved BEC products, developed landscape-level tools, and provided analytical support to the Chief Forester, regional and district managers, and other FSP researchers. The modellers also developed spatially explicit models to assist with strategic-level decisions, including future climate-change scenarios for the FFEI, and provincial-level modelling and analysis of the MPB outbreak for the Chief Forester's office and Regional Management Teams. The modellers additionally provided specialized technical support and advice to MFR staff on model development, spatial data management, GIS use, landscape-level analysis, and ecosystem mapping.



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Landscape Ecology Modelling – Research and Extension Highlights

- Contributed significantly to implementing the MPB Action Plan by developing new inventory and monitoring methods, and by analyzing the impacts of the current outbreak and management responses for Ministry managers.
- Developed new BEC products, such as GIS layers that simplify map units and facilitate use at different scales, and updated the provincial mountain pine beetle spread projection for the Land and Resource Data Warehouse.
- Responded to additional product requests from many clients, including the Forest Analysis and Inventory Branch, First Nations, industry resource managers, and staff with the MFR and the Ministry of Environment.

10 Biometrics

FSP biometricians provide statistical expertise to FSP researchers and other Ministry staff. They advise on the proper application of statistical methods, standards, and software for research and operational needs, and provide leadership in developing quantitative evaluations that assist policy decisions.

The statistics specialists during 2007/08 played a key role in a number of strategically important corporate initiatives. These included improving the stumpage system, refining log-scaling sampling, and assessing the timber supply implications of forest economics.

In the past year, biometricians developed statistical methodology and extension products on stocking standards and surveys for clients at the Forest Practices Branch and in forest district offices. For FREP team leaders, biometricians gave advice on sampling design and power analysis for evaluating effectiveness. They also provided statistical advice to improve TASS and TIPSY models, and to improve data collection and analysis for the Site Index – Biogeoclimatic Ecosystem

Classification (SIBEC), used to estimate site productivity. These initiatives are important for timber supply review and allowable annual cut determinations.

Biometricians collaborate with the Protection Branch to develop a decision-making system for prioritizing fire suppression responses.

Biometrics – Research and Extension Highlights

- Modelled the 20-year shelf life of MPB-killed wood with respect to changes in log grades. Linking this work to projections of MPB-related tree mortality has improved knowledge of the available fibre supply and economic outputs under various harvesting scenarios.
- Developed methods to examine the effects and risks of changing stocking survey parameters. This research provided policy support to Forest Practices Branch and Operations Division staff for evaluating the stocking standards proposed in forest stewardship plans.
- Collaborated with the Protection Branch to develop a decision-making system that can use several variables simultaneously for prioritizing fire suppression responses.
- Assisted forest pathologists in designing and analyzing a study that involved re-sampling stands that were previously declared free-growing to determine whether that status was maintained. This study has policy and liability implications related to the time at which a stand should be declared free-growing.
- Participated in the Economic Fibre Supply Project to develop a methodology for incorporating economics into timber supply analysis, particularly in management units affected by the MPB. The framework produced helps managers to better understand the impacts of forest economics on timber supply and is particularly relevant to the Chief Forester and policy makers in the Tenure and Revenue Division.
- Assisted the Revenue Branch in choosing a new sampling algorithm for the provincial weight-scaling system. This addressed the Ministry's requirement for a defensible and random means of selecting trucks to be scaled, while still maintaining a certain degree of regular log flow so that the industry's business operations are not unduly disrupted.

11 Coastal and Interior Tree Breeding

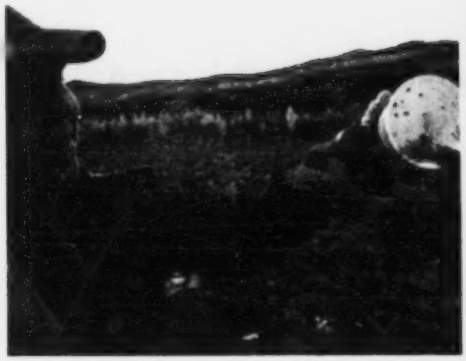
The Forest Genetics Section in the Research Branch has extensive tree breeding research programs for the Province's Coast and Interior. The Section's comprehensive genetic resource management programs are designed and implemented to ensure that forest tree materials are appropriately developed by conventional plant breeding practices. Programs also ensure that genetic resources are conserved and risks to genetic resources are reduced through adaptation and resilience to climate change and other disturbances.

The primary goals of FSP genetic research are to increase tree volume growth and improve wood quality at rotation age. These priorities support industry competitiveness and the Coastal Forest Action Plan goal of moving to harvesting second-growth through tree improvement activities.

In achieving its priorities, the main emphases of FSP genetic research are in establishing, maintaining, and measuring long-term tree breeding and genetic field trials for several conifer and some broadleaf species.

The Coastal Tree Breeding Program in 2007/08 supported addressing second-growth management issues on the Coast, such as rectifying poorly adapted planting stock, achieving free-to-grow status, adapting forest management activities to climate change, and improving industry competitiveness by protecting reforestation investments and enhancing long-term volume gains. Activities of the Interior Tree Breeding Program also contributed to addressing questions around maladapted planting stock in light of the more pronounced climate changes projected for the Interior. There was also a strong Interior research focus on genetic gains in growth, quality, and resistance to diseases and pests.

Other research areas included studying species-specific traits, such as Sitka spruce resistance to spruce weevil and western white pine resistance to white pine blister rust. Research also examined a broad array of questions related to patterns of genetic diversity, or genecology, for dozens of British Columbia's tree species. Other projects developed new quantitative approaches for genetic evaluations of selected germplasm, and developed genetic worth estimates that can be used in stand development models (such as TIPSY) to assess the impact of genetic worth of improved seedlots or vegetative lots.



Evaluating genetic resistance of interior spruce to terminal weevils.

Coastal and Interior Tree Breeding – Research and Extension Highlights

- Continued evaluating the genetic resistance of interior spruce to terminal weevils by raising and releasing a population of the pests for screening two spruce genetic tests.
- Selected 12 Southern Interior sites and acquired Class A and Class B seedlots for the first phase of the Facilitated Migration of Multiple Species Adaptational Trial. This research will improve understanding of how to best adapt forest management activities to climate change.
- Completed progeny test selections for resistance to Central Interior western gall rust among two Seed Planning Units: Prince George low lodgepole pine, and Nelson low lodgepole pine. This material constitutes the first set of genotypes specifically selected for producing western gall rust–resistant seed.
- Applied results from a study modelling the environmental effects on wood density in lodgepole pine to determine the impacts of climate change on wood quality.
- Continued work on the genetic basis of resistance in lodgepole pine to MPB attack. The results are facilitating considerations of options for increasing resistance to bark beetles, as well as informing decision-making around management options following the MPB outbreak.
- Completed measurement and early selection in the second phase of the advanced-generation coastal Douglas-fir breeding program that will lead to establishing the next generation of Douglas-fir orchards.

- Analyzed western redcedar parental breeding values for volume at rotation from 10-year height data. The findings show that breeding values for the top five parents from Series 1 vary considerably.
- Participated in a multi-agency collaboration investigating the genetic and ecological basis of western redcedar and yellow-cedar deer browse to address regeneration issues on the Coast. Research this year moved into third-generation deer browse–resistance breeding, with parental selections based on total needle monoterpenes from second-generation families.
- Estimated yellow-cedar clonal breeding values and updated the values in the Tree Improvement Branch's Seed Planning and Registry System (SPAR), enabling users to improve the genetic values of hedge orchards on the Coast.
- Established provenance–progeny test trials for bigleaf maple on Vancouver Island and the coastal mainland in support of the Coastal Forest Action Plan move to harvesting and planting hardwood species.

Mountain pine beetle killed the Lodgepole Pine Genetic Architecture Trial plantation at the Prince George Tree Improvement Station. This plantation provided excellent growth, disease and insect data collection opportunities for more than 3 decades. (Image courtesy of Lorraine Maclauchlan)

12 Conservation of Genetic Resources

The Forest Genetics Section undertakes both theoretical and applied research on forest tree genetic conservation. The Section receives input on its activities from the Forest Genetic Conservation Technical Advisory Committee of the Forest Genetics Council of British Columbia (FGC), and has a close working relationship with the Centre for Forest Conservation Genetics at the University of British Columbia. FSP scientists involved in gene conservation research provided substantial technical advice in 2007/08 to the Tree Improvement Branch and the Chief Forester on gene resource management issues. This included co-leading the Challenge Dialogue discussion to develop a new Forest Tree Genetic Resource Conservation and Research Management Strategy for the FGC.

The main research focus for the Section this past year involved continued work on cataloguing the conservation status of 50 British Columbia tree species, in collaboration with the Centre for Forest Conservation Genetics at the University of British Columbia. This project represented an important milestone in documenting the genetic diversity inherent in native-grown populations as well as the diversity contained in selectively bred trees. Activities included developing verification methods for key natural populations and designing programs and plans to fill the recognized gaps in genetic resources. This research supports the core business objectives and outcomes of the Forest Tree Genetic Resource Conservation and Management Strategy. A secondary research focus involved evaluating the potential effects of various climate-change scenarios on the naturally growing genetic reserves that are currently identified for each tree species in every seed planning zone, or biogeoclimatic subzone or variant.

Conservation of Genetic Resources – Research and Extension Highlights

- Determined optimum sampling approaches, based on studies conducted at the University of British Columbia, that can be considered for tree populations located well within the natural range of a species, versus tree populations present at the fringes of the range.
- Finalized the current status, priority, and management needs of key tree genetic test plantations in the FSP long-term installation inventory.
- Continued collecting whitebark pine seeds from across its range for future field testing and conservation.

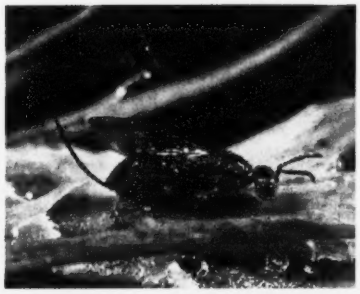
Researcher in light trap catching Dioryctria.

13 Ancillary Forest Genetics Research

Cone and Seed Pest Research—By improving knowledge of cone and seed pest species, their life histories, and their economic impact, this research is enabling the development of management techniques for reducing yield losses in seed orchards. Research for 2007/08 focussed on studying the life histories, damage potential, and pest status of important seed and cone pests, specifically western conifer seedbug, adelgids, Douglas-fir coneworm, and pine pitch moth. Other investigations comprised pesticide trials that evaluated the effectiveness of various systemically active ingredients and application methods. Overall, the FSP's cone and seed pest research is aimed at improving industry competitiveness by protecting the Province's public and private seed orchard investments.

Ancillary Forest Genetics – Research and Extension Highlights

- Established a host-finding study and a long-term mark-release-recapture project for the western conifer seedbug, *Leptoglossus occidentalis*. Results will aid seed orchard managers in understanding how this insect re-colonizes seed orchards every year.
- Completed a life history and pheromone characterization study, and established a long-term investigation into the reproductive behaviour of Douglas-fir coneworm, *Dioryctria abietivorella*. This work forms part of the foundation necessary for identifying methods of non-chemical control of this damaging pest by assisting in uncovering key life history traits that could be used to control the coneworm.
- Continued testing of systemic pesticides, in sprayable and injectable forms, at both interior and coastal sites. Optimizing pesticide applications is important for reducing costs and addressing public safety concerns.
- Studied whether irrigation influences the susceptibility of lodgepole pine to MPB. The bark beetle recently became a serious pest problem at Interior seed orchards, attacking over 800 trees at the Kalamalka Forestry Centre in 2006 alone.
- Examined the severity and long-term effects of damage caused by



Internal seed feeding insects may be killed by systemic pesticides.

Increased light intensity results in smaller leaves and pigment breakdown in paper birch.

Sequoia pitch moth, ***Synanthedon sequoiae***, a pest that has long plagued Interior tree seed orchards.

- Described a newly discovered natural enemy of larch adelgids.

Climate Change and Seed Transfer Research—This research component investigates the relationship between patterns of adaptive genetic variation and ecological variation, a field of inquiry termed genecology. Researchers use new tools and analytical techniques to improve understanding of how tree breeding programs might adapt to possible changes in the Province's climate.

Areas of focus during 2007/08 included examining the adaptation of seed-orchard seed for all major tree species to climate regimes across British Columbia in order to improve adaptation in tree breeding programs. Researchers also applied fine-scale climate models and other GIS tools to estimate the range of climate variables that affect natural selection and patterns of adaptive variation.

Additionally, work was conducted on using transfer curves to identify seed selection schemes suited to maximizing forest productivity and health. Research results were applied to refining seed transfer guidelines and developing new climate-based approaches to seed deployment, notably guiding revisions to the Chief Forester's Standards for Seed Use. Findings from research also helped stand development modellers refine provincial models, such as TASS, to incorporate the impacts of climate change on forest productivity.

Climate Change and Seed Transfer – Research and Extension Highlights

- Developed a multi-species adaptation trial to better understand Class A seedlot productivity responses across a wide climatic and latitudinal range.
- Established a large trial of improved and natural-stand seedlots of interior spruce. Data from this trial will be used to refine transfer guidelines for Class A and B interior spruce seed.
- Developed the first province-wide adaptive map for spruce using data collected from an interior spruce provenance.
- Refined reforestation strategies to ensure that British Columbia's forests are well-adapted to future climates and that managers can capitalize on changing climates.

Adaptive Physiology Research—Results from adaptive physiology research aid forest geneticists and forest nursery managers in producing stress-resistant trees with high growth potential. This area of FSP research examines genetic variation in frost-hardiness, photosynthetic potential, phenology, heat, drought, and other stress tolerances. During 2007/08, research centred on studying the relationship between patterns of genetic variation in adaptive traits and site ecology in populations of British Columbia conifers and hardwoods. This research helps forest nurseries maximize the field performance of planted seedlings while minimizing the risk of seedlings being poorly adapted. It also improves the speed and accuracy of tests used to predict overwinter storability of seedlings, field performance potential, and balanced seedling growth—all important considerations in tree nursery management.

Investigating fall frost-hardiness of multiple seed sources of coastal western redcedar, Douglas-fir, and western hemlock to estimate their readiness for overwinter frozen storage.

Adaptive Physiology – Research and Extension Highlights

- Progressed in developing physiology tools designed to estimate population responses to a variety of climates and ultimately assist with seed transfer under potential future climates.
- Assessed the responses to water and temperature stresses of 150 populations of interior spruce, and described patterns of genetic variation. Knowledge of these patterns informs decisions made about assisting the migration of spruce populations in response to climate change.
- Examined late-winter photosynthetic potential in 127 North American populations of white spruce in two contrasting environments. By contributing insights on how a wide range of many populations has adapted to environmental conditions, this research will assist with planning strategies for adapting to climate change.
- Investigated fall frost-hardiness of multiple seed sources of coastal western redcedar, Douglas-fir, and western hemlock to estimate their readiness for overwinter frozen storage. Results from this work will assist growers in implementing stock handling strategies that maximize post-planting performance.

Appendix 1 Forest Science Program involvement

FSP researchers often applied their knowledge to Ministry priorities by collaborating on formal teams, committees, and working groups. These forums enabled FSP specialists to effectively bring their scientific expertise to bear on current issues, policy development, operational challenges, and scientific collaboration. Listed below are the groups, both within and outside of the provincial government, in which FSP staff participated during 2007/08.

Ministry of Forests and Range

FRPA/FREP Related

- Fisheries-Sensitive Watersheds Working Group
- Fish-Stream Crossings Working Group
- Forest and Range Evaluation Program—Biodiversity, Fish/Riparian, Forage and Associated Plant Communities, Soils, Terrain, and Wildlife Resource Values Teams
- Joint Management Committee
- Temperature Sensitive Streams Working Group

Mountain Pine Beetle Related

- Forests for Tomorrow, Operational Fertilization Program
- Mountain Pine Beetle Inventory and Monitoring Project Team
- Mountain Pine Beetle Provincial Analysis Team, Mid-term Timber Supply Group
- Mountain Pine Beetle Research Strategy and Implementation Framework Working Group
- Mountain Pine Beetle Survey Group, Inventory Branch

Others Led by MFR

- Cariboo-Chilcotin Ecosystem Restoration Operations Committee
- Chief Forester's Public Advisory Committee
- Chief Forester's Standards for Seed Use
- Coarse Woody Debris Management Guidelines Working Group
- Coastal Hardwood Species Committee
- Coast Regional Implementation Team, Silviculture Working Group
- Ecosystem-Based Management Working Group
- Forest Tree Genetic Resource Conservation and Management Challenge Dialogue
- Future Forest Ecosystems Initiative, Scientific Foundation Team
- Government Actions Regulation Resource Feature Committee
- Landscape Objectives Working Group, Prince George
- Long-term Multi-species Facilitated Migration Trial Planning Committee
- Provincial Silviculture Systems Working Group
- Provincial Soil Conservation Working Group
- Silviculture Committee, Nadina Forest District

- Southern Interior Wildfire Erosion Committee
- Stocking Standards Technical Advisory Committee
- Timber Supply Review Committee

Interagency

Land Use Planning Related

- Cariboo-Chilcotin Ecosystem Restoration Working Group
- Cariboo-Chilcotin Land Use Plan (CCLUP)
- CCLUP Biodiversity Conservation Strategy Committee
- CCLUP Caribou Technical Working Group
- CCLUP Mule Deer Committee

Species-at-Risk Related

- Canadian Marbled Murrelet Recovery Team and Habitat Recovery Implementation Group
- Canadian Spotted Owl Recovery Team
- Caribou Recovery Implementation Groups
- Coastal Tailed Frog Habitat Working Group
- Marbled Murrelet Recovery Team
- Provincial Mountain Caribou Science Team
- Queen Charlotte Ermine Recovery Team
- Queen Charlotte Northern Goshawk Habitat Recovery Implementation Group
- Species at Risk Coordination Office, Mountain Caribou Science Team

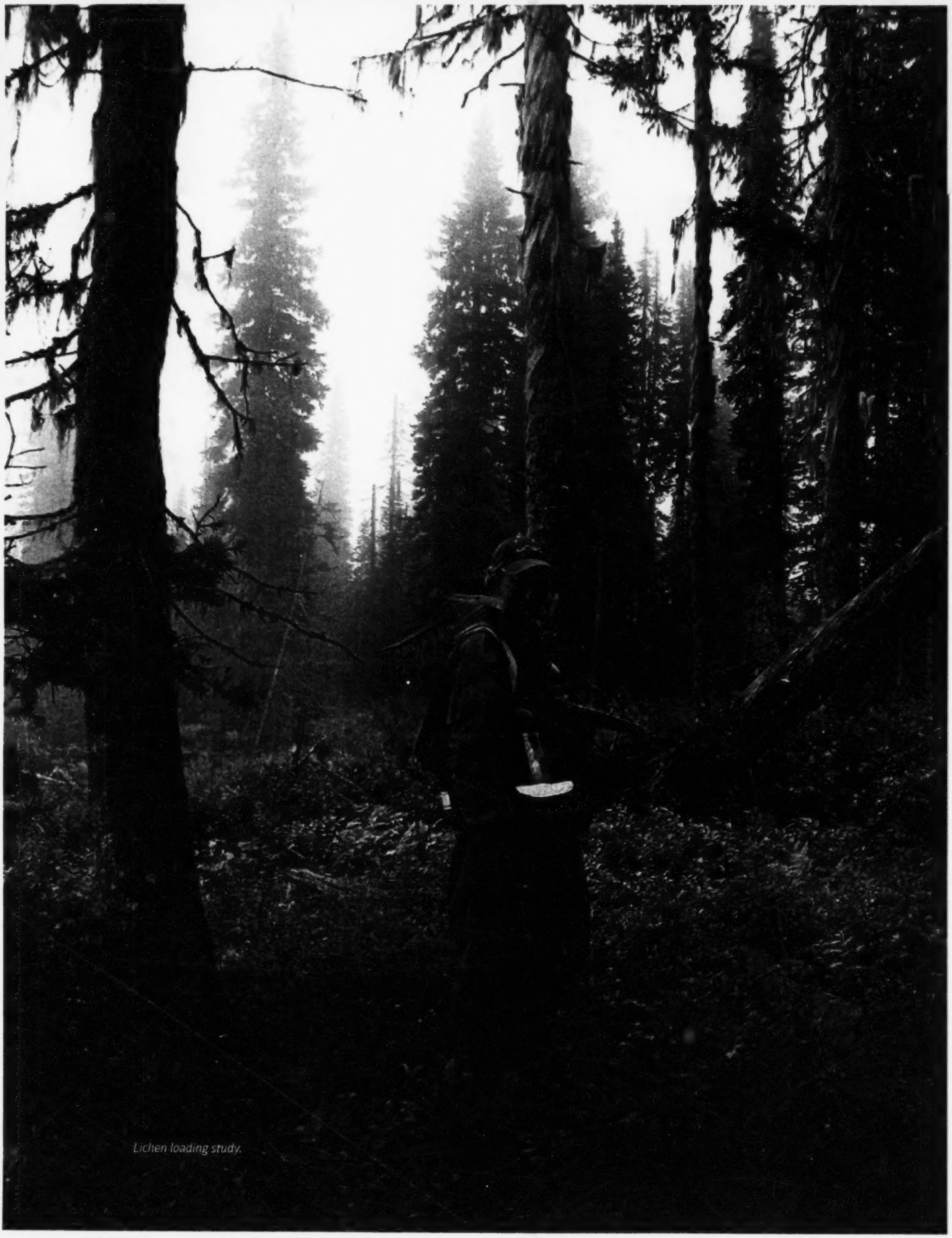
Other Provincial Government

- Coast-Cariboo-Chilcotin Invasive Plant Committee
- Forest Investment Account–Forest Science Program, Timber Program Advisory Committee, Growth and Yield Modelling Program Subcommittee, and Sustainability Program Advisory Council
- Forest Practices Board
- Inter-Agency Non-Timber Forest Resources Committee
- Science Committee, Ministry of Environment

Non-Governmental

Provincial

- Big Trees Committee, Conservation Data Centre
- British Columbia Rural and Remote Health Research Network
- Bulkley Valley Centre for Natural Resources Research and Management
- College of Applied Biology
- Committee on Watershed Stewardship
- Division of Engineers and Geoscientists in the Forest Sector (a Division of the Association of Professional Engineers and Geoscientists of BC)
- E-Flora BC Advisory Committee



Lichen loading study.

- First Nations Forestry Council
- Forest Investment Account–Forest Science Program (FIA–FSP) Forest Science Board, Program Advisory Committees, Peer Review Committees
- Forest Genetics Council of BC, Cone and Seed Pest Management Technical Advisory Committee
- FORREX (Forest Research Extension Partnership) Board of Directors, Watershed Management Working Group, Riparian Areas Regulation Working Group, and Forest Resources Dynamics Working Group
- Grasslands Conservation Council of BC
- Habitat Acquisition Trust
- Hardwood Silviculture Co-operative
- Hectares BC
- Joint Practices Board (Association of BC Professional Foresters and Association of Professional Engineers and Geoscientists of BC)
- Northern Interior Regional Drinking Water Team
- Northwest Data Sharing Network
- Rare Ecosystems Group

National

- Canadian National Vegetation Classification Working Group
- Canadian Society for Agricultural and Forest Meteorology
- Canadian Water Resources Association
- Environmental Science Advisory Committee, Department of National Defence
- Interagency Committee on Non-timber Forest Products
- Mixedwood Management Association, Review Committee
- Pest Management Regulatory Agency
- Western Forest Insect Work Conference

International

- Alluvial Fans 2007 Conference, Organizing Committee
- American Meteorological Society
- Frontiers of Forestry in China, Editorial Committee
- International Union of Forest Research Organizations (IUFRO)
- IUFRO Biodiversity in Forested Ecosystems and Landscapes Conference Organizing Committee
- International Vegetation Classification, Hierarchy Revisions Working Group
- United States / British Columbia Plant Association Correlation Team

Academic

- Centre for Natural Hazards Research, Simon Fraser University
- Genome BC Forestry Project, University of British Columbia
- Mixedwood Ecology and Management, University of Northern British Columbia
- Pacific Climate Impacts Consortium, University of Victoria
- Stand Management Cooperative, University of Washington
- Sustainable Forest Management Network

Appendix 2 FSP research and extension collaborators

Listed below is a sampling of the organizations with which the FSP collaborated on research or extension projects during the 2007/08 fiscal year.

- BC Timber Sales
- Canadian Forest Service
- Centre for Forest Conservation Genetics, University of British Columbia
- Forest Analysis and Inventory Branch, MFR
- Forest Genetics Council of British Columbia
- Forest Research Extension Partnership (FORREX)
- Haida Gwaii First Nation
- Huu Ay Aht First Nation
- Pacific Climate Impacts Consortium, University of Victoria
- Protection Branch, MFR
- U.K. Forestry Commission
- U.S. Forest Service
- University of British Columbia
- University of Northern British Columbia

Forest Science Program Staff Locations

Forest Science Program Organizational Structure

ECOLOGY AND EARTH SCIENCES

FORESTRY AND TECHNICAL SERVICES

FOREST GENETICS

NORTHERN INTERIOR FOREST REGION

SOUTHERN INTERIOR FOREST REGION

COAST FOREST REGION

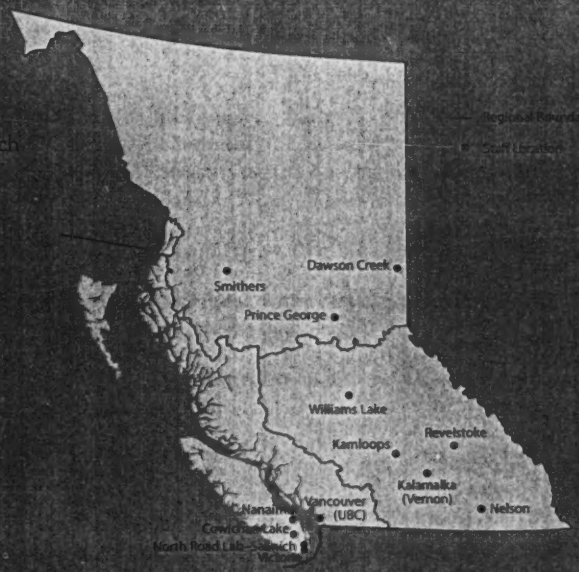
Forest Science Program Staff Locations

Research Branch: Victoria, Saanich (North Road Laboratory), Cowichan Lake and Kalamalka Research Stations, Kamloops, Prince George, University of British Columbia, Revelstoke, Smithers

Coast Forest Region: Nanaimo, Smithers, Victoria

Northern Interior Forest Region: Prince George, Smithers, Dawson Creek, Victoria

Southern Interior Forest Region: Kamloops, Williams Lake, Nelson



Forest Science Program Organizational Structure

Research Branch and Regional Forest Science Sections and Disciplines

ECOLOGY AND EARTH SCIENCES

- BEC–Plant Ecology
- Climatology and Soil Conservation
- Mountain Pine Beetle
- Silviculture Systems and Forest Dynamics
- Watershed Research
- Wildlife Habitat, Range Ecology, and Non-timber Forest Resources

FORESTRY AND TECHNICAL SERVICES

- Analytical Laboratory
- Stand Development Modelling
- Strategic Analysis (Biometrics, and Landscape Ecology Modelling)
- Finance and Administration
- Technical Communications (Library, Knowledge Management, and Production Resources)

FOREST GENETICS

- Coastal Tree Breeding
- Cone and Seed Pest Research
- Forest Genetics Research and Management
- Interior Tree Breeding
- Research Stations

NORTHERN INTERIOR FOREST REGION

- Climatology
- Ecology
- Geomorphology
- Hydrology
- Silviculture
- Soils
- Wildlife Ecology

SOUTHERN INTERIOR FOREST REGION

- Geomorphology
- Hydrology
- Plant Ecology
- Silviculture Systems
- Soils
- Wildlife Ecology

COAST FOREST REGION

- Forest Ecology
- Geomorphology
- Hydrology
- Silviculture Systems
- Soils
- Wildlife Habitat Ecology

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